MACHINERY.

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CINCINNATI MILLING MACHINE CO.'S SHOPS.

E. M. CHACE

A TRIP through the shops of the Cincinnati Milling Machine Co. impresses one with the general cleanliness and orderly condition of the whole plant and the systematic and thorough manner in which the materials are handled from the rough to the finished state.

A glance at the plan view shown on the following page will give an idea of the arrangement of the departments on the first floor and, as the two upper floors are similar, an idea also of the extent of the shops since their last addition. All the machine parts pass through the warehouse on the first floor and on through the different departments necessary for their finishing and finally reach the finished stock-room on the third floor. Great care is taken that the parts are not moved over more ground than is necessary to accommodate the number of men who work on them.

The shipping and receiving room is located on the main street (Spring Grove avenue) and through it passes all the rough and finished stock, supplies, etc. The rough stock is delivered to the warehouseman, who sends it to the different departments on receipt of the shop order tag illustrated in Fig. 5.

The coupon is torn off by the warehouseman and after being stamped with date that he delivers the stock to the shop, it is sent to the office to the clerk, who keeps a record of the rough stock. The coupon is sent to the office by a messenger who makes regular trips through all the shops and offices. The remainder of the tag goes with the work through the shop and the timekeeper writes the men's names on the back of the card as it passes from one to another.

It has been suggested that each tag be stamped on the back (in a machine for that purpose located in each department) with the date, hour and the man's number. This could be done by the man who accepts the job from the foreman or by the foreman as he delivers the tag to the man with his instructions.

The object of having these names or numbers on the back of the tag, is to give the cost clerk a chance (when he receives the tag from the stock room to make his final entry) to see if the timekeeper has kept a proper record of the operations on the pieces and also to indicate to the foreman at any time who worked on the same piece previously.

These tags originate in the stock room (all orders for anything are issued from here) and are sent to the rough stock clerk, after being approved by the superintendent or his assistant. The clerk of rough stock returns the tag to the stock room only when his records show plenty of stock for this order. The tags, of course, go from place to place by the messenger mentioned before, it generally taking about five hours to get back to stock room after starting out on its initial trip.

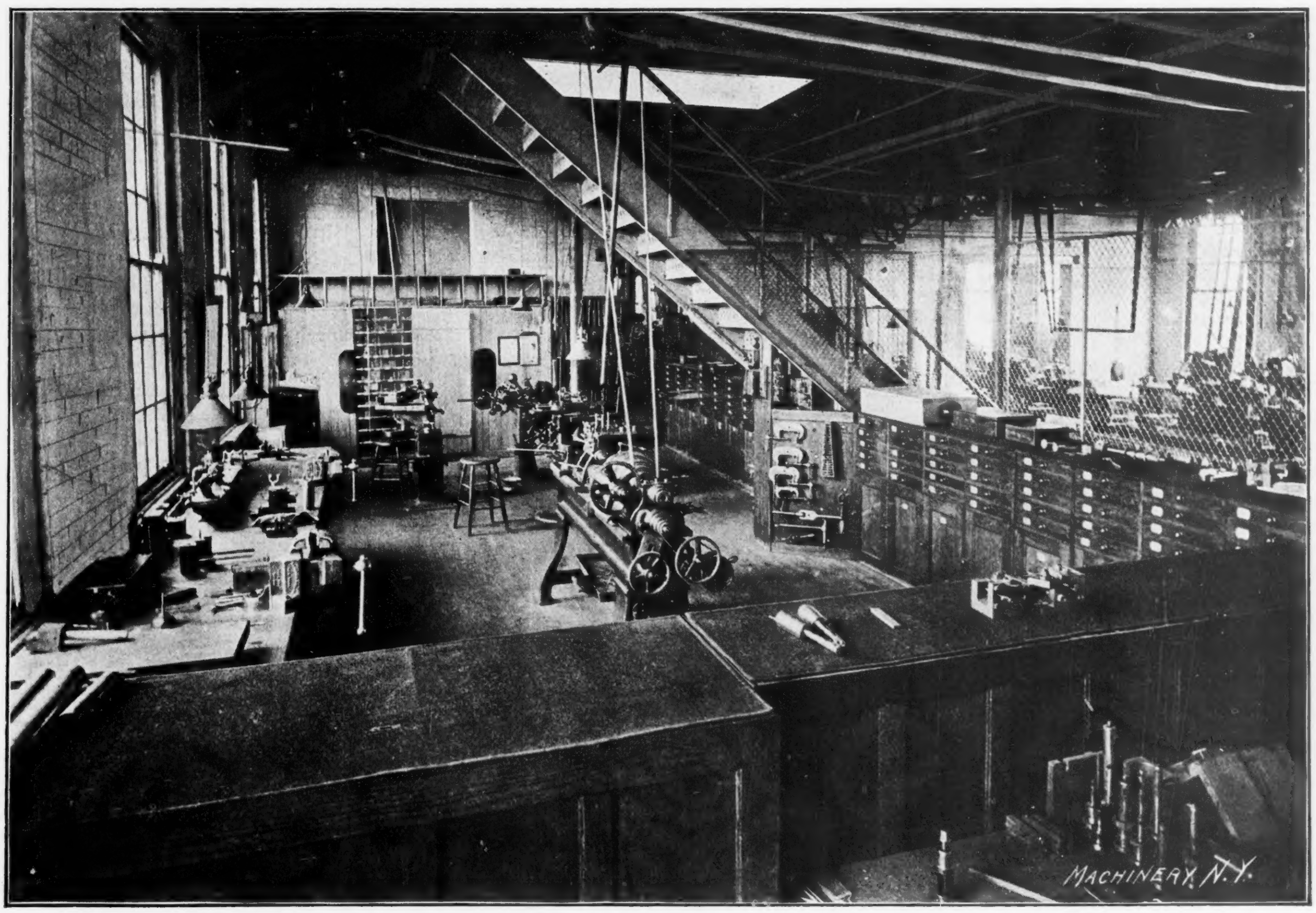


Fig. 1. View in Tool Room. Card Indexes and Drawers and Cases for keeping Tools are shown at the right.

The larger number in the left hand corner of the tag is called the shop order number and is used principally as a distinguishing mark for keeping the time. Contrary to the usual custom the men do not put down their own time, but a time-keeper keeps going from one part of the shop to another making entries in a book of the time on a certain piece. In this way

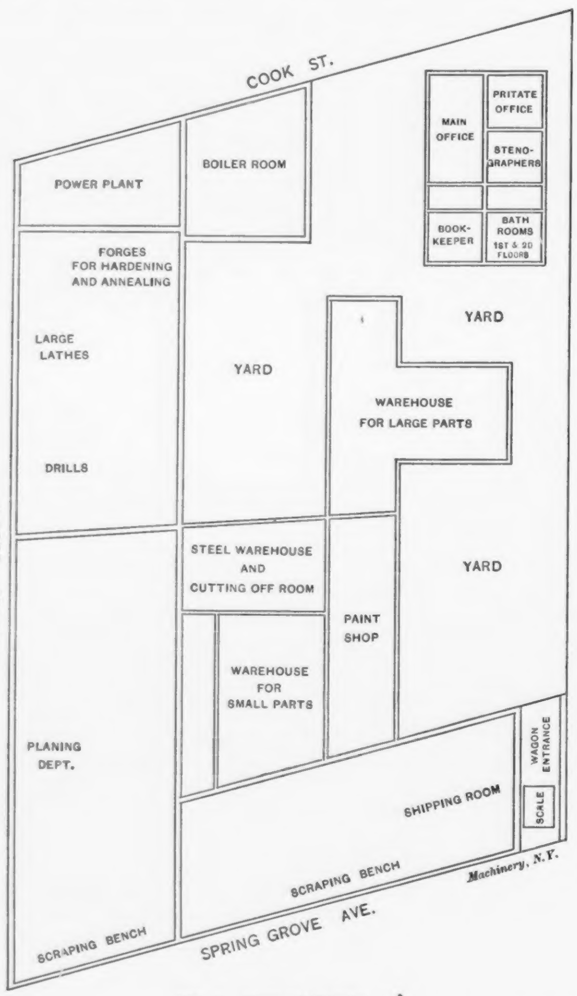


Fig. 2. Plan of Works.

there is no necessity of making bookkeepers of the 275 men and boys in the shop. A number of the different pieces are tested after each operation before they pass from one department to another, so that if a piece is spoiled it can be discarded as soon as possible.

Next to the shipping room is located the paint shop shown in plan Fig. 2 and also in Fig. 4. All parts of the machines that will need painting are brought here and painted after everything is finished on them except a final scrape or something of that character which is done just before assembling. This arrangement makes it possible to use the best means for getting this work done in a most expeditious manner and keeps the dust (from the filler and emery paper) from the rest of the shop.

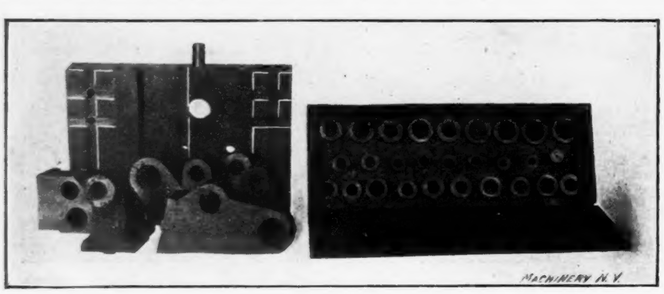


Fig. 3.

On the right of the picture can be seen a special steam coil with an air pipe so arranged as to blow air over the coil and on to the painted work. This has been found to be quite an advantage in getting good smooth work in the winter time. Compressed air can be used for blowing out the dust. A traveling crane is provided for lifting the heavier parts.

All the planers are on the first floor and each has a separate foundation. They have lately been equipped with variable speed countershafts, as shown in Fig. 8, page 3, which have been found of great assistance in reducing the time on the work. They seem to supply the long felt want or the missing link or something of that sort and put a planer in a position to be adjusted to get the maximum amount of work done on each piece. On the same floor are two automatic machines making machine details from the solid bar. Gear blanks are drilled, bored and

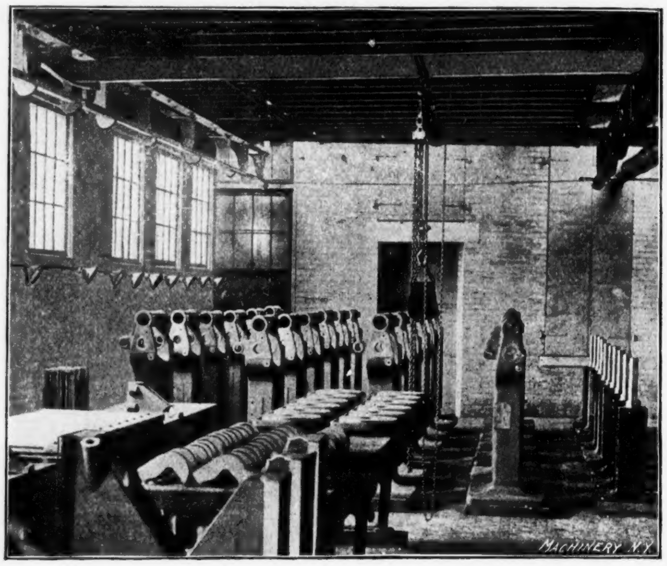


Fig. 4. Paint Shop, which is fitted for Blowing Heated Air over the Painted Work.

reamed to size and a cut taken off the outside so that the piece when finished runs nearly true. All these pieces are then either ground or finished perfectly true in a lathe. One of the pieces being made is a ball bearing ring 2½ inches diameter and 3-16 inches thick. Six of them are made at one time on one machine, which turns out about 20 each hour. The material used is the same as is used for making the shop tools.

On the second floor in the center of the main building is the tool room in which are arranged the jigs, small tools, standard plugs, gages and blue prints. The tools are all kept in drawers and the smaller jigs in closets shown in Fig. 1 and each drawer or closet is labeled on the outside to indicate the contents. This figure shows only about two-thirds of the tool room on account of the partition next to the jig closets.

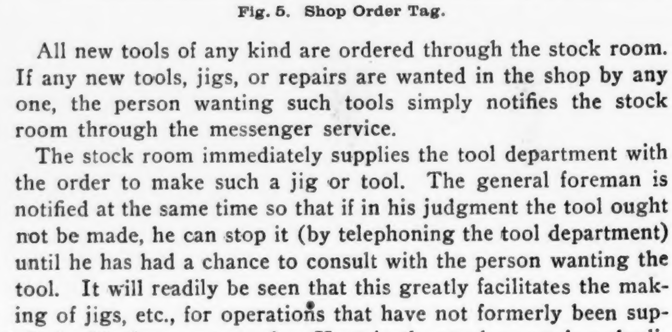

THIS CARD TO BE ATTACHED TO WORK IN OPERATION.
S. O. 1973 Am't. 100 Date. JUN 27 1900
Name of Piece. Change Gear 72 T. 10" O.K.
Remarks
Delivered to Stock Room
Date
O. K. N. G.
1973 S. K.
Approved by
Supt.
Date JUN 28 1900
REPORT SPOILT OR MISSING PARTS TO THE TIME KEEPER.
CIN. MILLING MACH. CO.
PUT YOUR NAME AND NUMBER ON OTHER SIDE.
WAREHOUSE COUPON.
S. O. 1973
Name Change Gear 72 T. 10" O.K.
Amt. Wanted 100.
Amt. Del'd
Date
S. K.
RETURN TO STOCK CLERK.

Fig. 5. Shop Order Tag.

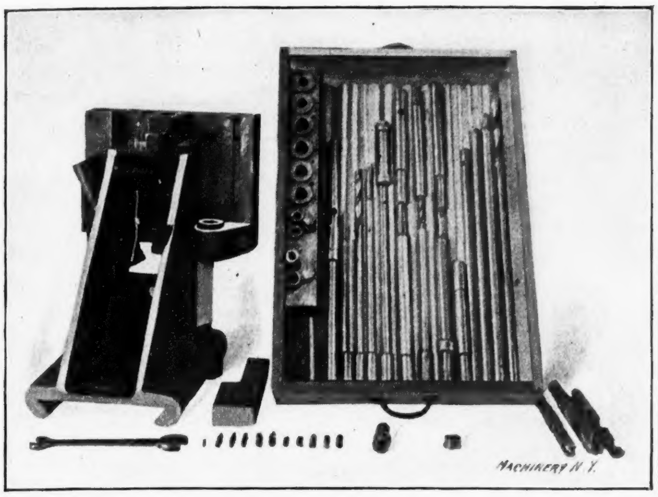
All new tools of any kind are ordered through the stock room. If any new tools, jigs, or repairs are wanted in the shop by any one, the person wanting such tools simply notifies the stock room through the messenger service.

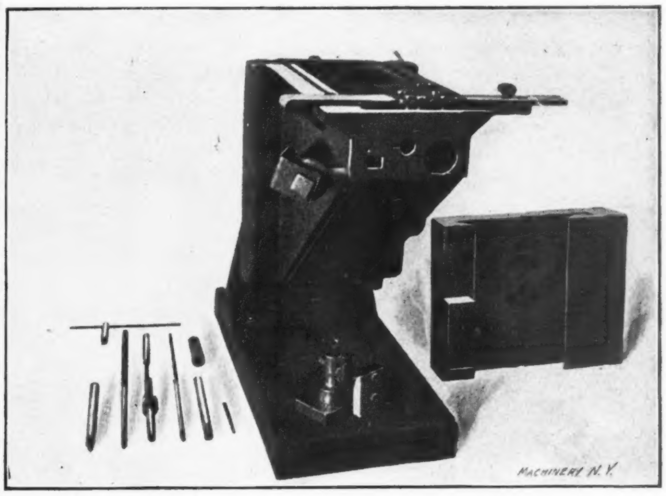
The stock room immediately supplies the tool department with the order to make such a jig or tool. The general foreman is notified at the same time so that if in his judgment the tool ought not be made, he can stop it (by telephoning the tool department) until he has had a chance to consult with the person wanting the tool. It will readily be seen that this greatly facilitates the making of jigs, etc., for operations that have not formerly been supplied with the proper tools. Kept in the stock room is a duplicate set of the tools which are in the tool room. The object of this is to keep the stock in the tool room, of which there is an exact record, at the same height all the time by drawing on the stock room immediately whenever a new piece is needed. In

addition to the tools in the tool room each vise and drill press hand has a set of drills and taps and possibly some counterbores. This obviates the necessity of his going to the tool room except on rare occasions. These tools are charged directly to the man using them who, in case he leaves has to return them to the stock room.

Figs. 3, 6 and 7 illustrate some jigs used on the milling machine knee with necessary tools. These tools are put into boxes spaced to fit them and are used for this one piece only. The boxes have lists pasted on the inside of the lid, on which is written the size and number of the tools necessary to complete the piece and that number of tools must appear at all times in the box. After being used the tools are returned to the tool room, inspected and sharpened, or repaired if necessary, and are then put away ready to be used again. All jigs and drawings are recorded in card indexes seen at the right in the far end of Fig. 1. Each card contains a history or biography of the jig or drawing since its advent to the tool room. Every facility is provided the tool keeper (who by the way is not a machinist) to have the tools put into the best possible shape.

On the third floor is the tool making department, shown in Fig. 9. It is intended in this room to erect each new machine or





Figs. 6 and 7. These illustrations, with Fig. 3, show samples of Special Fixtures and Tools, which in each case are complete for one piece of work, and are used for no other piece.

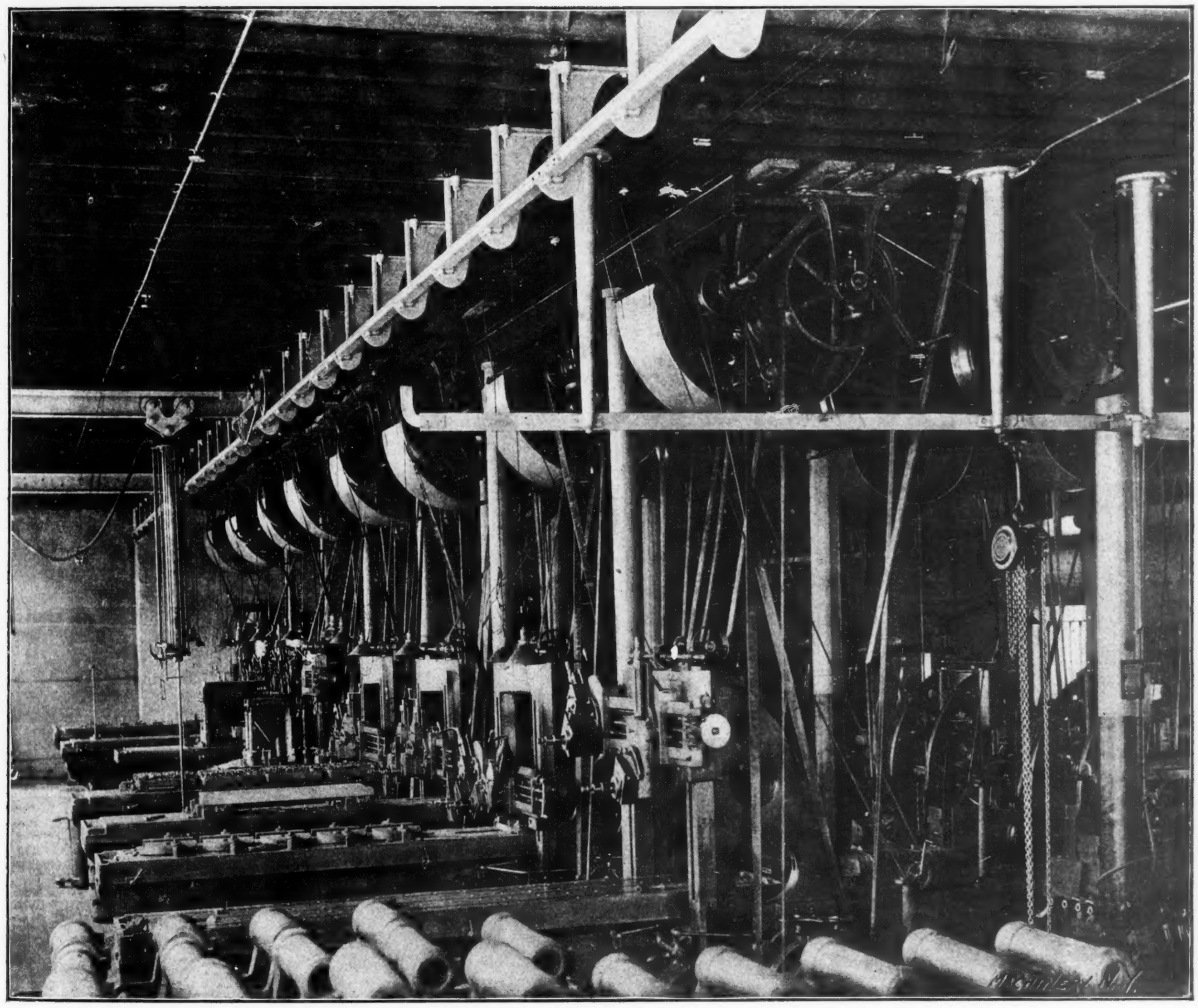


Fig. 8. Planer Department. Each planer has a separate foundation, is served by the traveling air hoist and has a variable-speed drive.

attachment as it is designed. The special tools and jigs which are designed as soon as the piece itself is finished in the drawing room, are made and used on the first machine so as to be sure everything is all right before making the first lot.

Fig. 10 gives a view of the assembling department. Each man is given a machine to erect and an inspector is constantly testing the machines as they are assembled. The shop number of the machine and the man's name who is doing the erecting are recorded with the test and a man's standing is made contingent upon the faithfulness of his work.

To the left of Fig. 10 are the trucks which hold all the parts to be assembled for each machine. Each truck has a list showing the number of parts necessary.

In case any piece is missing, or in other words, is not furnished by the stock room with the other pieces, a note is made of it on this slip by the stock keeper and the man knows on inspecting his list that he need not look for that particular piece on the truck, but must find out from the stock room when he is nearly ready for it, how soon he can have it. The stock room is located on the same floor as the assemblers, which makes it very convenient.

The men for assembling are generally men who have worked in the shop in other positions and demonstrated their ability on work of lesser importance. Each machine is driven from a countershaft during erection and as a final test has a cutter put on its own arbor and a cut taken to test the adjustments.

The office building shown in the small engraving on the first page contains in addition to the rooms for the usual office force for a business of this class, a library, Fig. 11, bathroom, dark room for developing photographic plates on the second floor and two lunch rooms on the third floor.

A section of the larger of these is shown in Fig. 12. In this lunch room any kind of meal can be had. The charges are just about enough to pay running expenses. The men indicate on a bill of fare the articles they want for dinner the next day, so that when they come up at noon everything is ready for them. In the smaller room a regular dinner is served. This is a little more expensive, but well within the reach of those who want a good meal. The library and bathrooms are open all day and until 9 o'clock in the evening and are very well patronized.

Next to the library is the foreman's rooms in which are the measuring machines and trade catalogues. There is also here a copy of the suggestions that have been made by the men in the shop. These are looked over by a committee each six months and prizes awarded for the suggestions that are considered of any value. There have been such a quantity of these up to the present time that it has been impossible to adopt all that were considered good. A special man is to be appointed in the near future, however, to develop and put in working order the most of them as promptly as possible.

Next to the office and located partly in the new addition is the power plant, consisting of one large Greenwald-Brown engine, two dynamos, one for light and one for power, and a special testing apparatus for the efficiency of the coal used. There are also a large air compresser, a ventilating and heating plant and boilers with smokeless furnaces.

Everything is fitted up in the best of the latest practice in power economy. Last but not least is a laundry plant for washing the wipers that are used in the shop. These are made of canton flannel and are delivered and collected twice a day. At present about 800 are washed per day. Aside from being cheaper than waste, they are much better to wipe things with and on account of their being collected each day there is not the risk from fire that there is from waste.

A visit to these shops should be a great pleasure to any one interested in machine shop practice. The company extends a cordial invitation to any one (interested or not) to visit them.

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UPSETTING COLD STEEL RIVETS BY HYDRAULIC PRESSURE.

Probably the fly-wheels of the 5,000 H. P. vertical compound Allis engines at the Metropolitan Street Railway power plant at Ninety-fifth and Ninety-sixth streets, New York city, present as fine examples of built-up construction as can be found. These wheels weigh about 150 tons each and are 28 feet in diameter. The hub is of cast-iron to which are bolted the ten cast-steel arms and segments of the rim. The segments are held together by wrought-iron keys dove-tailed into the ends of the segments and shrunk in place. To the sides of the segments are riveted sixteen layers of steel plates 1⅛" thick, eight on each side. There are 160 plates in all, ten in each layer, and they are so placed that the joints are broken in regular order. There being fourteen thickness at the weakest points, the ultimate strength of the rim is very high.

The method employed in riveting the plates in position is exceedingly interesting when it is considered that the steel rivets are 3" in diameter and 28½" long when upset, and that the upsetting is done by hydraulic pressure with the rivets cold. The ends of the rivets are all centered and turned down for a short

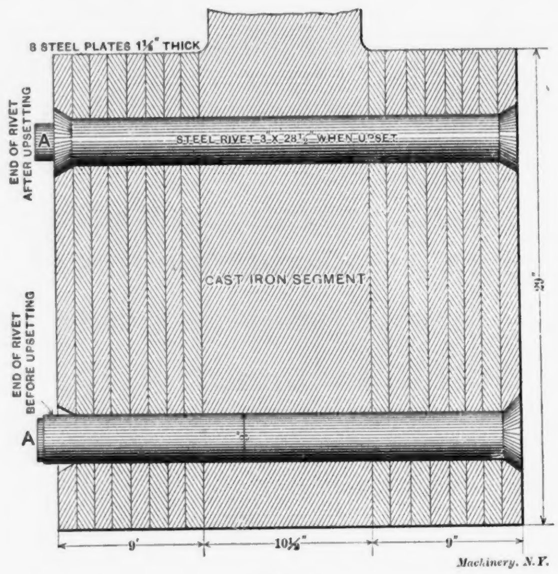


Fig. 1.

distance, as shown at A, Fig. 1, the part A being about ⅛" long. This projection is for seating the hollow die shown in Fig. 2 which is so made that when used on a rivet, it shears or "flows" the metal away from the core A and forces it into the countersunk plate. As may be seen, the face of the die is divided into four parts, the parts A A doing the upsetting and the relieved parts B B allowing the metal of the rivet under them to remain undisturbed. The upsetting of a rivet, therefore, requires two operations, the die being turned one-fourth of the way around to complete the upsetting action. The pressure required is said to range from 300 to 400 tons.

The riveter is of very heavy construction and made in the usual C form to embrace the width of the fly-wheel rim. It is

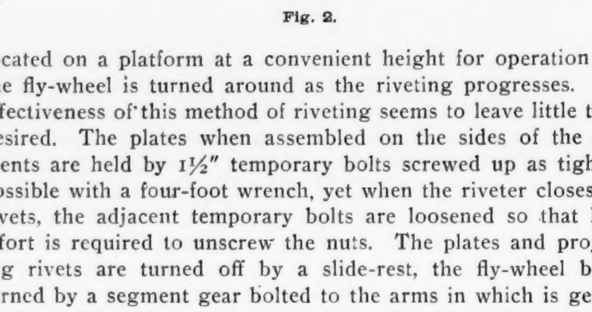
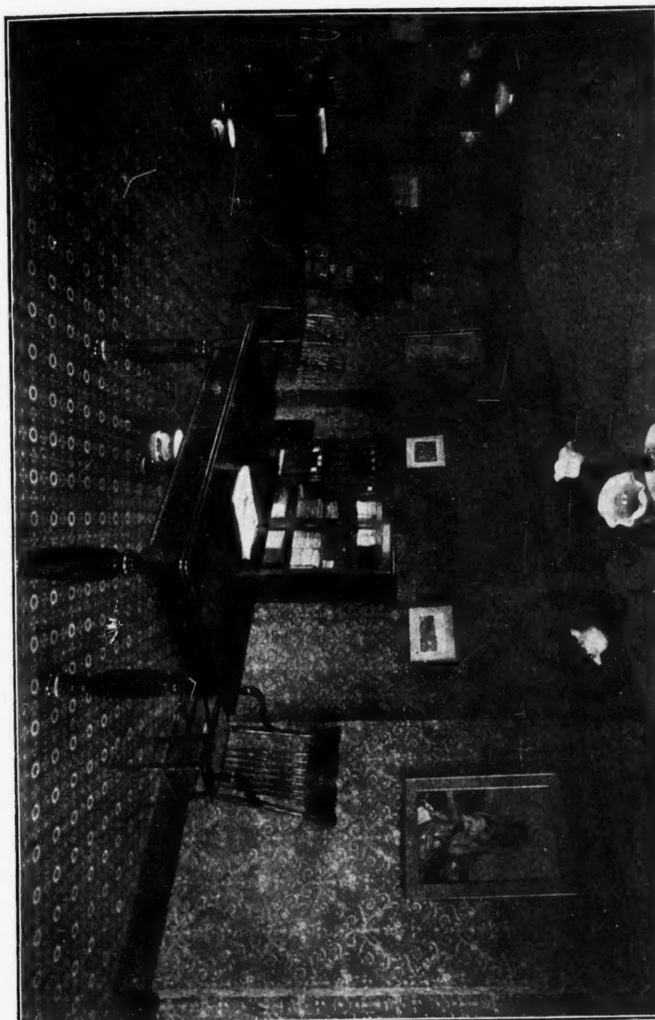


Fig. 2.

located on a platform at a convenient height for operation and the fly-wheel is turned around as the riveting progresses. The effectiveness of this method of riveting seems to leave little to be desired. The plates when assembled on the sides of the segments are held by 1½" temporary bolts screwed up as tight as possible with a four-foot wrench, yet when the riveter closes the rivets, the adjacent temporary bolts are loosened so that little effort is required to unscrew the nuts. The plates and projecting rivets are turned off by a slide-rest, the fly-wheel being turned by a segment gear bolted to the arms in which is geared a pinion driven by an electric motor. By this method of construction a perfectly true running wheel is obtained and one having a high factor of safety.



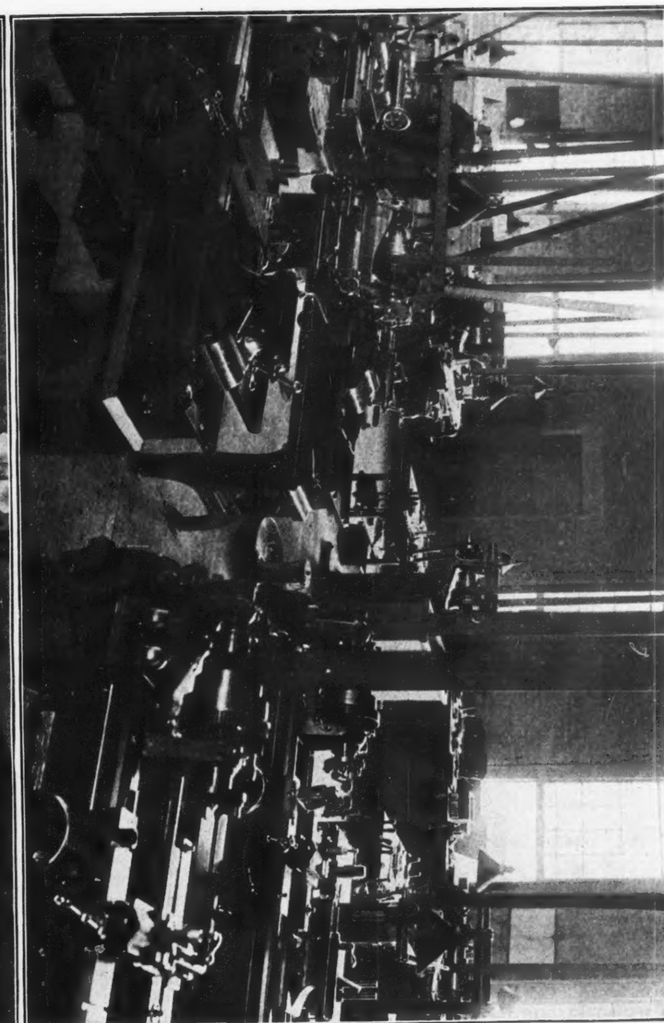
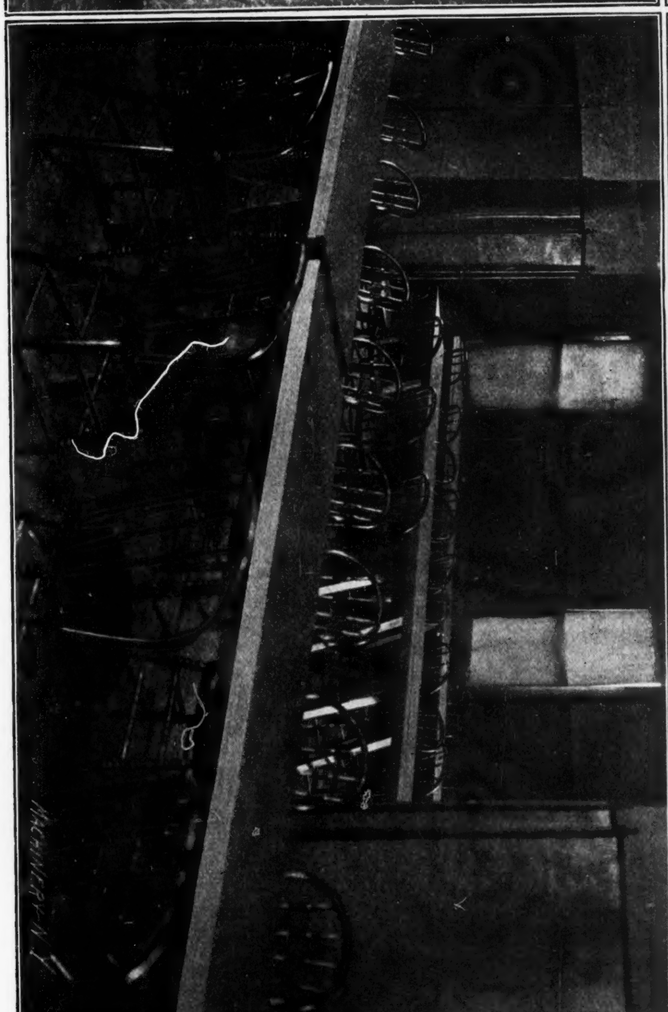


Fig. 9. Tool-making Department.
Fig. 11. Employees' Library and Reading Room.



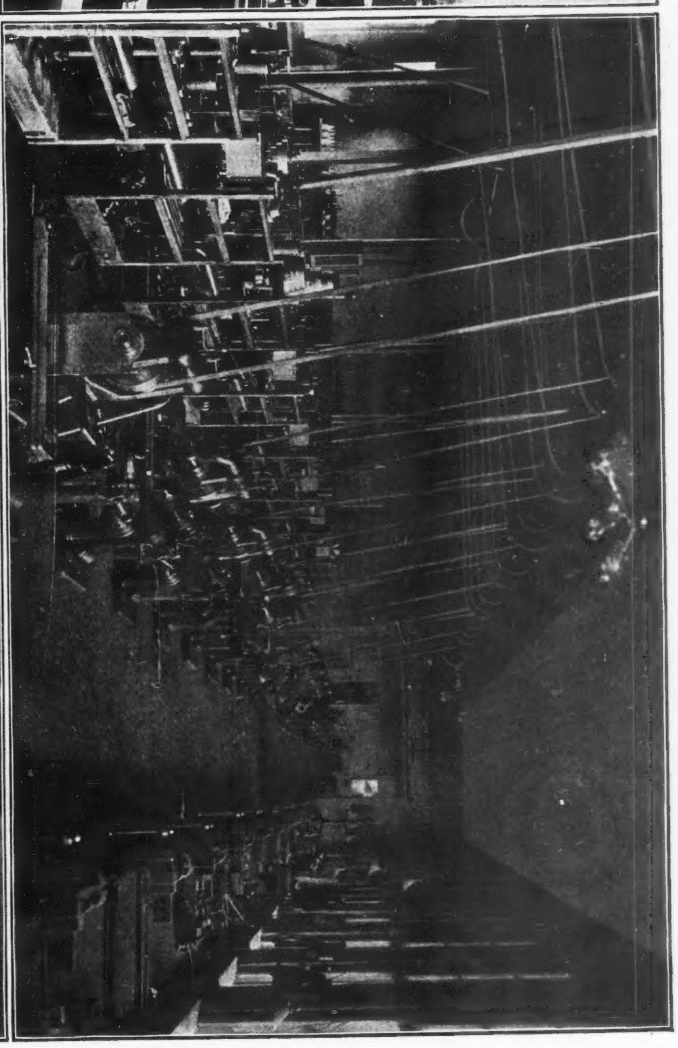


Fig. 10. Assembling Department, showing trucks for holding parts of Machines.
Fig. 12. View in Lunch Room.

A CONVENIENT AND EFFICIENT BORING BAR.

LEVER FEDE

The accompanying photographs and detail drawings illustrate a boring bar, and some of the uses to which it may be put, that we have used for several years with good success. Referring to the illustrations, Fig. 1 shows the machine complete. The bar is of cast-iron, 5½ inches in diameter by 8 feet long and is designed for boring cylinders of from 16 to 30 inches in diameter of any stroke up to 5 feet. The bar is driven by a worm and worm wheel and power is furnished by a small engine, which drives the worm through a rope drive and a sheave, which latter is on the worm shaft and is connected to it by a clutch.

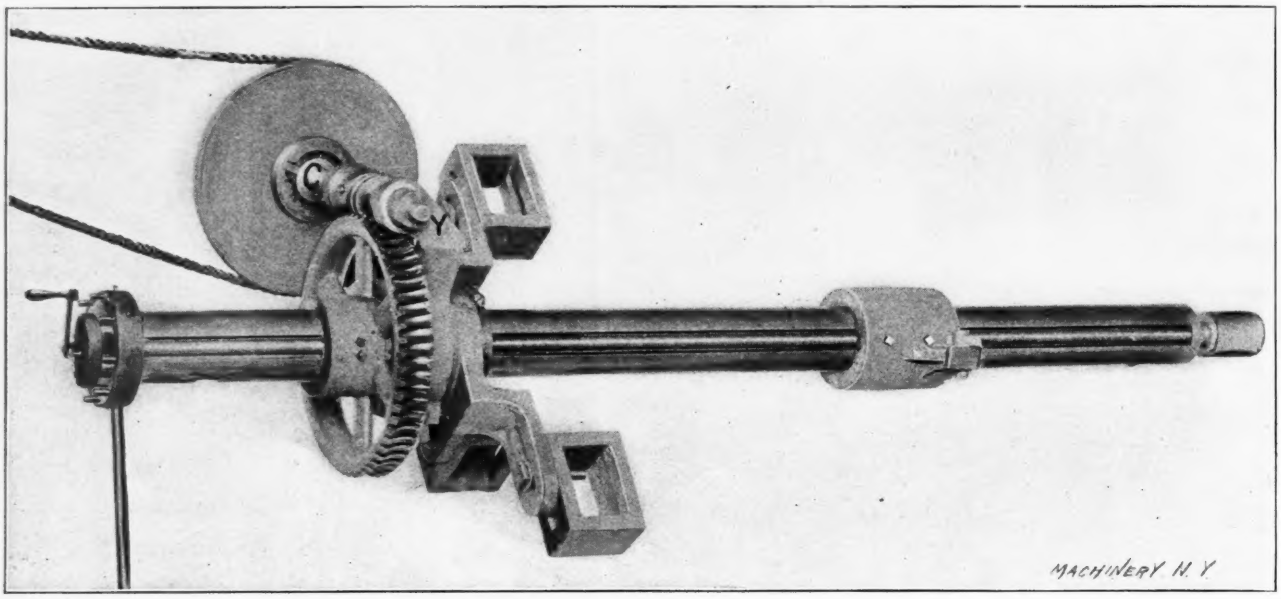


Fig. 1. Boring Bar Complete.

A pulley may be substituted for the sheave if desired, but we prefer the rope drive, as it is more flexible, and in connection with a feature of the machine (which will appear later) it is possible to make a great many changes of the bar from one position to another and drive it without changing the power setting. A ¾-inch manilla rope joined with steel couplings, has pulled a cut with a broad tool 1-32 inch deep by 4-10 inch feed and enlarged a 22-inch by 48-inch Corliss cylinder 1-16 inch in 35 minutes.

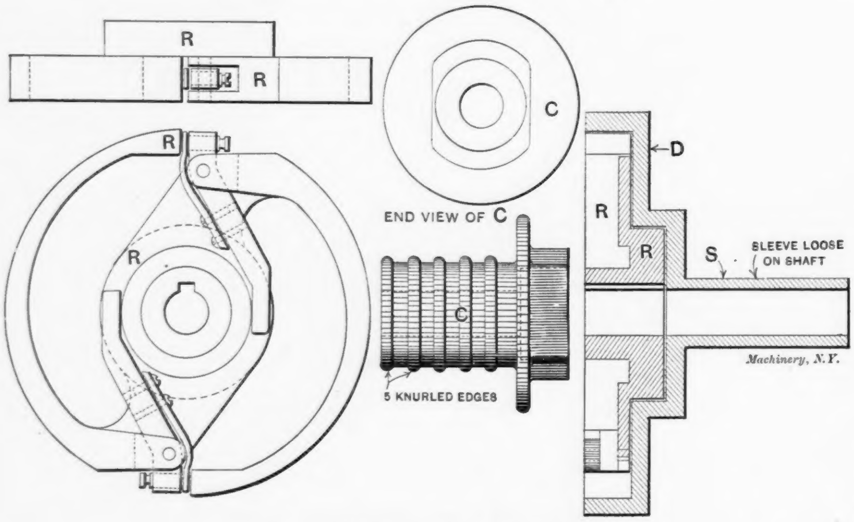


Fig. 2. Details of Clutch Mechanism.

The clutch connecting the sheave with the worm consists of a sleeve S (Fig. 2) with a disc and an enlarged rim D working loosely on the worm shaft and carrying the sheave or pulley. Keyed to the same shaft is an expansion ring R, which, with the arms that support it, fits inside of the disc D. The details of the expansion ring are indicated at the left in Fig. 2 and are also clearly shown in the reproduction of the photograph in Fig. 3. To operate the levers, that expand or contract the expansion ring, is a sliding collar C, which is on the worm shaft between the clutch and the worm. This collar has a knurled end next the machine, a protecting flange near the clutch and a cylindrical portion flattened on two opposite sides and extending under the clutch levers to operate them. This collar works freely on the shaft and has sufficient end play to permit it to be entirely withdrawn from under the levers.

To start the machine the collar is slipped with the flat sides under the levers and turned until the clutch takes hold. To stop the machine the operator grasps the collar and at the same time pulls it endwise out of the clutch.

The worm shaft is carried in bearings in a yoke Y, Fig. 3, which is bored to fit the turned outside of the main bearing of the bar. This yoke may be turned entirely around on the bearing and held in any position by a clamping bolt, thus making it possible to take power from any point when boring either vertical or horizontal engines. This we consider a very desirable feature.

The worm wheel drives the bar by a feather and is secured by the two set screws. The end thrust is taken by the hub of the worm wheel on the clamp collar K, Fig. 3, when feeding out or in. In our smaller bars, which are used a great deal more than the large ones, a bushing is provided which revolves with the bar and takes the wear.

The tools are held in a post and no shimming or grinding is necessary to bring the finish tools right, as they can swing in a plane at right angles to the work.

The feed is by the familiar star wheel and pins set in a collar, which latter is kept from turning by a rod screwed into the collar and allowed to strike the floor or some convenient part of the machine. If preferred, the rod may be tied with a cord, which will break if the pressure becomes excessive. The feed screw is 5-pitch, square thread and with a four-point star and eight pins in the collar gives a range of feeds from 1-20 inch to 4-10 inch.

We have bored a 16-inch by 42-inch cylinder, two cuts through, and re-counterbored both ends in eight hours, this time including all setting of bar and taking down, etc. The variation from truly round and straight has never exceeded .003 inches and in this case was about .0025 inches, being larger at the crank end. This is the usual result, and is due, perhaps, to the springing of the clamping blocks and tripod which form the outer support of the bar.

We can get better results in re-boring by using a single tool with 1-10-inch to 3-20-inch feed for truing, following this with a broad finish tool and 4-10-inch feed. The speeds can usually be

much higher than in new work, which is due, I think, to the iron being saturated with oil near the surface and to the light cuts. If I am mistaken about this, I would like to be corrected.

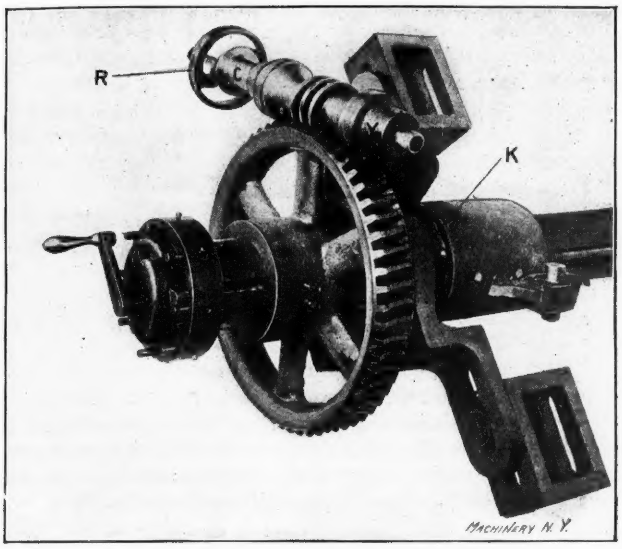


Fig. 3. Showing Clutch and Driving Gear.

The boring head, which is shown in Fig. 4, has no special features. In this sketch, B is the bar, N the half nut, S the screw and H the head, carrying the tool. The nut is held in place in the head by screws, and to save time in returning the head the screws may be removed, the head slipped along the bar, the nut

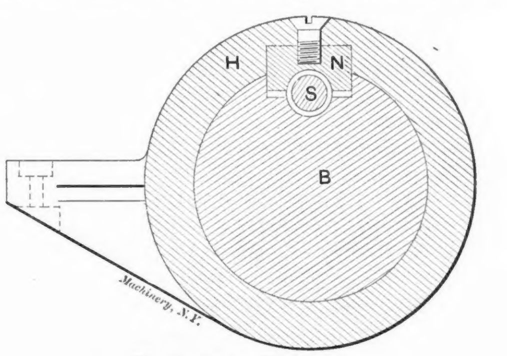


Fig. 4. Boring Head.

lifted out and set back, after which the head is again slipped over the nut and the screws put in. While this is not a new arrangement, it is very convenient where there is room to get at the screws after having taken a long cut.

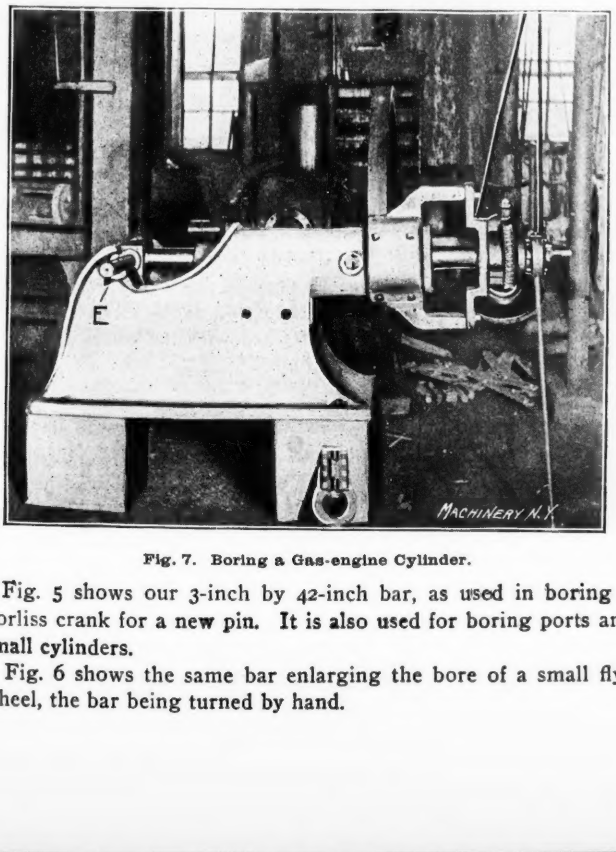


Fig. 7. Boring a Gas-engine Cylinder.

Fig. 5 shows our 3-inch by 42-inch bar, as used in boring a Corliss crank for a new pin. It is also used for boring ports and small cylinders.

Fig. 6 shows the same bar enlarging the bore of a small flywheel, the bar being turned by hand.

Fig. 7 shows our 3½-inch by 54-inch bar, as used to bore, face and turn the end of a two-cycle gas engine cylinder. In doing this job the forward end of the bar is supported by a bearing in a turned piece, E, which is held in the main bearings of the engine. After the bar is properly set, the main bearings are babbitted and the piece that supports the bar is held in position by clamps

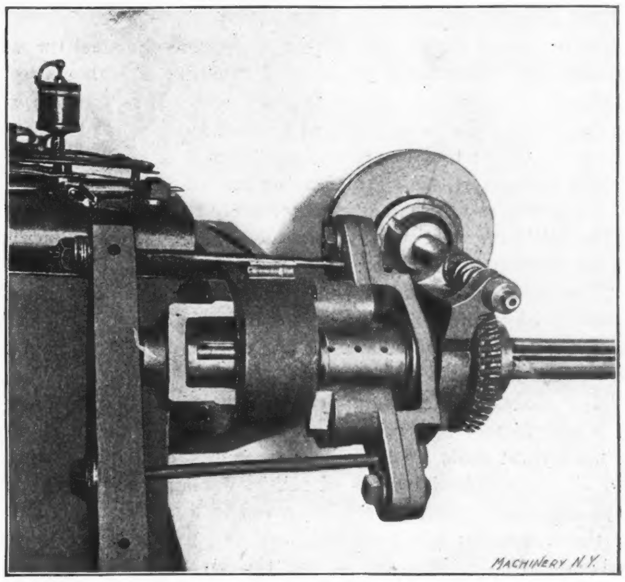


Fig. 5. Bar Rigged for Boring an Engine Crank for the Crank Pin.

while the boring is in progress. The back end of the bar is supported by a spider which fits over the end of the cylinder and is held in place and adjusted by set screws. The projecting arms of the spider carry the regular driving mechanism of the bar, allowing room for the turning and facing head to swing clear. The facing head is under control of the feed screw for setting the cut when facing, and for feeding when turning.

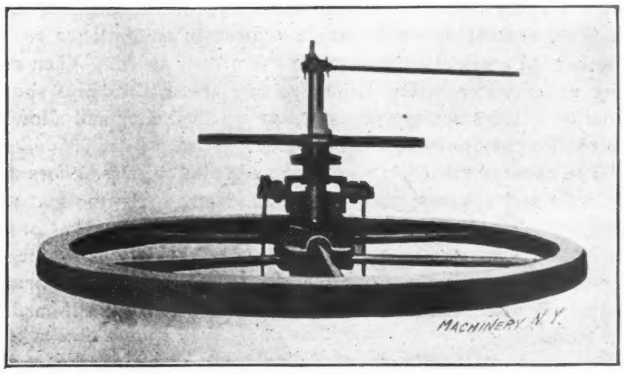


Fig. 6. Boring a Flywheel.

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NEW PROCESS FOR TREATING TOOL STEEL.

A year ago a representative of MACHINERY paid a visit to the works of the Bethlehem Steel Co., So. Bethlehem, Pa., and secured matter and illustrations for articles that appeared in the October and November numbers of the paper. It may be remembered it was then stated that the cutting speeds in vogue at the machine shops of this company were at least 50 per cent. higher than the writer had seen in use elsewhere, and that extensive experiments had been conducted to determine the best speeds for work upon the high carbon steel, of which this company makes a specialty. These tests were under the direction of Mr. F. W. Taylor, the machine shop superintendent, who had the valuable assistance in this important work of Mr. Maunsel White, the engineer of tests.

It now appears that this investigation, conducted primarily to compare the merits of the various standard steels then on the market, has lead to the discovery and development of a method of treating tools that produces results probably never before approached; and while two years ago the capacity of the forge department of the Bethlehem Steel Co. was largely in excess of that of the shops, the advent of this hardening process has completely

reversed the condition of things, and it has become necessary to increase the capacity of the forging department, to keep pace with the demands of the shop.

The new process is known as the "Taylor-White" process, the patents for which have been purchased by the Bethlehem Steel Co., and the shop rights are to be sold, the amount charged depending upon the number and character of the tools in any particular shop.

The virtue of the process is that it gives to the steel the very valuable and exceptional property of retaining a high degree of hardness when heated to a visible red heat. It is possible with one of these tools to cut steel at a speed so great as to heat up the point of the tool to redness and have it continue to cut for several minutes at this speed, leaving an unusually smooth finish on the work, as well as cutting accurately to size.

The following particulars about the process have been sent us by the Bethlehem Steel Co.:

"The practical speeds at which these tools will run has been found to be from two to four times that of any steels which we have experimented with, and we have endeavored to obtain the best in the market."

"The process, which is applied after the tool has been dressed or machined to shape, penetrates to the center of the steel, even in the largest tools we have ever treated, i. e., 4 inches square. All of the standard brands of self-hardening steel which have been experimented with, are improved to a more or less extent by the treatment; it is preferred, however, to use a steel of special composition, in order to get the greatest uniformity, and maximum results. This special steel forges so much more readily than the general run of self-hardening steels that tools of difficult shapes may be easily made up."

"We have also discovered a simple and comparatively rapid method of annealing our special steel, by which tools may be easily machined to shape, making it applicable to twist drills, chasers, inserted cutters, etc., which have heretofore not been made from self-hardening steel."

"A great advantage in the use of these tools is that when cutting dry at the rate of maximum efficiency, the chips should come off blue, these blue chips enable a foreman at a glance to tell whether the work is being done at the proper speed. When running under water at the proper cutting speed, the chips should show blue immediately upon shutting off the water and allowing the tool to cut dry for a few moments."

"The apparatus used in the "Taylor-White" process offers also a simple and effective means of heating any other tools at uniform temperatures, which can be easily controlled, so that ordinary carbon steels can be hardened through the use of the same apparatus at temperatures which will insure greater uniformity and higher qualities in this class of steel, as well as of self-hardening steels."

"As is well known, tempering steels of different makes and different qualities require different temperatures for hardening to obtain the best results; therefore, by means of our apparatus, which is capable of closely controlling temperature, these points may be accurately determined for each class of steel, and made use of in daily practice. The operation of the process is extremely simple, as it is controlled by apparatus which regulates the different steps, and does not require skilled or expert labor."

* * *

ELECTRIC PROCESS FOR DRILLING AND SLOTTING METALS.

In the April issue, mention was made of an electric apparatus for locally annealing armor plates so that holes for the fastening bolts can be drilled and other machine operations rendered possible. While this process appears to be satisfactory, it necessitates two operations for accomplishing the desired end. Not so with the Cowper-Cowles process, recently briefly outlined in the London "Electrical Review," and which is alleged to perform some wonderful work in penetrating plates, etc. By this method, holes of any shape such, for instance, as those outlined in Fig. 3. are produced in armor plates or other metal, by the direct action of an electric current. The metal powder as fast as removed, is deposited on a needle-shaped electrode from which it is washed away by the rapid circulation of the electrolyte contained in the nozzle of the apparatus.

In the first experiments the electrolyte was projected directly on to the iron to be drilled, a strong current of electricity being caused to flow from the metal to be drilled through the jet of

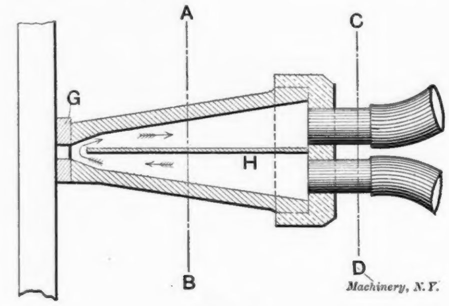


Fig. 1.

liquid and thus back to the source of electricity. This method was found to be fairly satisfactory, but the holes were not sufficiently true. A nozzle was then constructed, such as shown in Fig. 1, the electrolyte being rapidly circulated through the nozzle and around the baffle plate H placed down the center, so as to get

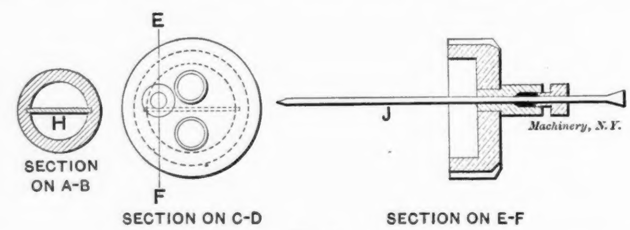


Fig. 2.

free circulation. A pointed rod, J, Fig. 2, fitted in a gland, is so arranged as to be near the end of the baffle plate. This needle forms the negative electrode, on which the iron is deposited as a powder, due to the high current density, and is washed away by the rapidly circulating electrolyte.

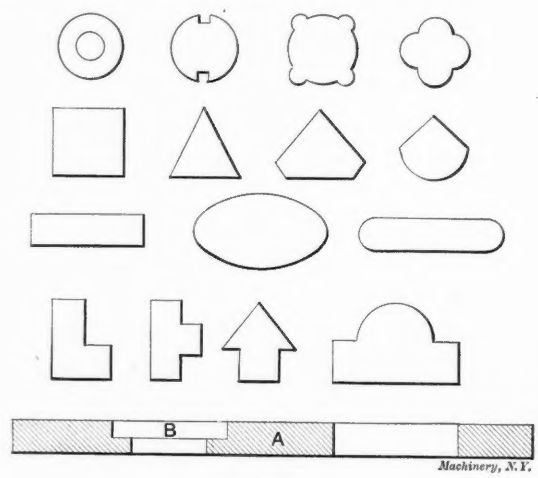


Fig. 3.

The end of the nozzle is fitted with a rubber washer G which can be easily removed and which has a hole through it of exactly the size and shape as that desired in the metal plate. It is claimed that this process can be used in marine construction beneath the water line, the salt water acting as the electrolyte. On other work, better results are obtained with the electrolyte composed of a weak solution of sulphuric acid.

* * *

A project is on foot in Chicago to make briquettes from the mud of the Chicago river, to be used in the place of coal for power and heating purposes. It is said that this mud is as rich in oil and other hydrocarbons as that obtained from the bottom of the Thames river, in England, which is being exploited by a company of English capitalists. While there is no doubt that the mud and ooze found at the bottom of all sluggish rivers is very rich in carbonaceous matter, the difficulties met in drying and burning it makes the problem of using it for fuel an exceedingly difficult one.

THE INERTIA OF THE RECIPROCATING PARTS OF A STEAM ENGINE.

C. H. Benjamin.

Those who read the article on the design of fly-wheels, in the October, 1899, number of Machinery, may remember that it was necessary in that article to assume the amount of energy alternately stored and restored by the fly-wheel. It is the object of the present article to show the method of determining this excess and deficiency of energy for different speeds and points of cut-off. If the pressure exerted upon the crank pin of an engine in the direction of its motion were always the same, no fly-wheel would be necessary and the motion of the crank would be uniform.

There are three principal causes which tend to make this pressure vary: 1, the variation of steam pressure on the piston due to expansion of the steam, as shown on an indicator card. 2, the variation in pressure required to accelerate and retard the reciprocating parts, i. e., the piston, piston rod, cross-head and connecting rod, and, 3, the irregularity due to the connecting rod and crank motion. The first cause need not be discussed at length, as it is familiar to all engineers. The second and third causes are so related that they cannot be separated and must be discussed at the same time. To use a familiar illustration, let us suppose a 100-pound block of ice resting upon the glassy surface of a frozen pond, so that it slides without appreciable friction. If we apply a horizontal pressure, however small, the block begins to move slowly, and, if the pressure is greater than the friction, it will move more and more rapidly, i. e., with an accelerated motion. If we apply a great pressure the block moves more promptly and the acceleration will be more evident. However great the pressure, the motion will be slow at first, the speed increasing as long as the pressure is applied. To retard or stop the block when in motion, will require a similar pressure in the opposite direction. The more suddenly the block is stopped the greater the pressure required. If a force of a hundred pounds be applied to this hundred-pound block, it will move as a body falling freely and its velocity will increase at the rate of 32.2 feet per second. If a force of only fifty pounds is applied, the velocity will increase only one-half as fast, or 16.1 feet per second.

In general the rate of acceleration or retardation of a body's motion will be proportional to the force causing it. In symbols let:

W=weight of body in pounds.

g=acceleration of gravity=32.2 feet per second.

F=applied force in pounds.

a=increase in velocity each second.

then:

$$a = \frac{Fg}{W} \text{ and } F = \frac{Wa}{g} \qquad (1)$$

Example. What force will be required to change the velocity of a mass 240 pounds by 32 feet per second in 8 seconds?

$$a = \frac{32}{8} = 4$$

$$F = \frac{Wa}{g} = \frac{240 \times 4}{32.2} = 30 \text{ pounds, nearly.}$$

The reciprocating parts of a steam engine stop at the end of each stroke and begin the next stroke with a motion very slow at first, but increasing rapidly, until, near mid-stroke, they are moving with the same speed as the crank. The velocity then as rapidly decreases, until they gradually stop at the end of the stroke. To start this heavy mass of metal in motion and to increase its velocity so much in so short a time, requires the exertion of a considerable pressure. A portion of the energy of the steam is thus diverted from its object and is absorbed by the reciprocating parts, instead of finding its way to the crank pin. After mid-stroke the heavy mass of these parts, now moving at full velocity, surges against the crank pin, assisting the steam pressure and restoring the energy absorbed during the first part of the stroke.

In order to find the magnitude of these forces, it is evident from our formula that we must know the weight of the reciprocating parts and the rate at which their velocity changes, i. e. the acceleration and retardation. Referring to Fig. 1, let P represent the cross-head pin of an engine, PC the connecting rod and CO the crank, turning in the direction of the arrow. Draw the tangent CT to represent the velocity of the crank pin and make its length = CO. Produce PC to intersect the vertical on O at K and draw the horizontal line CL.

Denote: CO by r

PC by nr = l

CT by v

angle COP by O

angle CPO by P and the velocity of piston and cross-head by u.

Then it can be shown by method of instantaneous center* that on the same scale that CT or CO represents the velocity of the crank pin, OK represents the velocity of the piston. Or, in symbols,

$$\frac{u}{v} = \frac{OK}{OC}$$

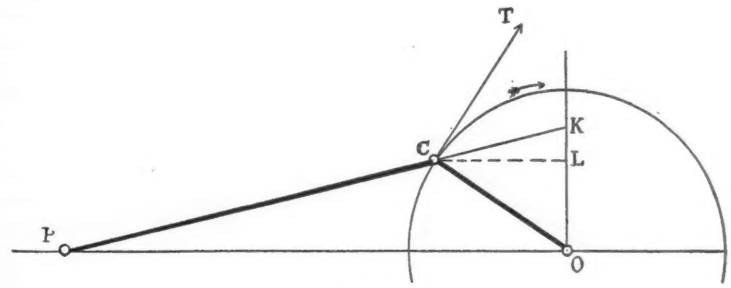


Fig. 1.

OK is divided at L into two parts, OL and LK. The part OL shows the velocity of piston due to the crank motion, and the part LK that due to the swinging of the connecting rod.

In symbols:

$$u' \text{ due to crank} = OL = v \sin O$$
$$u'' \text{ due to rod} = CK \sin P$$

It is sufficiently accurate in practice to take:

CK = CL = v cosO. Also by trigonometry: sinP : sinO =CO : CP = r: nr, therefore, $\sin P = \frac{\sin O}{n}$

Adding u' and u'' and substituting values of CK and sinP,

$$u = u' + u'' = v \sin O + \frac{v \cos O \sin O}{n}$$
$$= v \sin O \,(1 + \cos O/n)$$

It will be noticed when C turns to any position to the right of OK, that K will fall below L and LK will be negative. Therefore, for the entire stroke we should write:

$$u = v \sin O \,(1 \pm \cos O/n)$$

the plus sign for the angles between 0 and 90°, and the minus sign for the angles between 90° and 180°.

By the usual methods of the calculus it can be proved that the rate of change of u (i. e., the acceleration of the piston and cross-head) is:

$$a = \frac{v^2 \cos O}{r} \pm \frac{v^2}{nr}(2\cos^2 O - 1)$$

As already shown, the force required to produce this change is:

$$F = \frac{Wa}{g} = \frac{Wv^2 \cos O}{gr} \pm \frac{Wv^2(2\cos^2 O - 1)}{ngr} \qquad (2)$$

To recapitulate: W is the weight of all the reciprocating parts, in pounds.

v is the velocity of the crank pin in feet per second.

r is the radius of the crank in feet.

n is the ratio of the length of connecting rod to that of crank, (usually = 6).

Cos O can be found in any table of natural sines and cosines for the different values of O from 0 to 180°.

At the dead points, cos O = 1 and;

$$F = \frac{Wv^2}{gr} \pm \frac{1}{n} \cdot \frac{Wv^2}{gr} \qquad (3)$$

But Wv^2/gr is the familiar expression for centrifugal force. The force required to start the reciprocating parts at the beginning of the stroke is then 1/n th greater than the centrifugal force which these same parts would have if revolving with the crank pin. At the end of the stroke the force required is 1/nth less than the centrifugal force.

* See Machinery, March, 1897, p. 211, Fig. 16.

If we should plot a curve to represent equation (2), we would get something like Fig. 2 for the forward stroke, the vertical lines showing values of F and the line AB representing the stroke of the engine. The dotted line shows a similar diagram for the return stroke. F at the beginning has the value given by the plus sign in equation 3, diminishes rapidly and becomes 0 at the point C, which corresponds to the time when the connecting rod is at right angles with the crank, just before half-stroke. The shaded area up to this point shows energy absorbed in accelerating the reciprocating parts. F then becomes negative and the motion is retarded until the piston comes to rest at B, the value

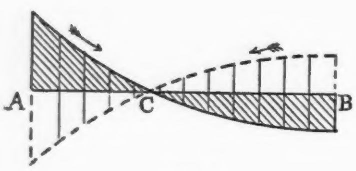


Fig. 2.

of F now being that given by the minus sign in equation 3. The shaded area below the line CB shows the energy restored by the reciprocating parts when they are helping to push the crank and must of necessity be equal to the shaded area above the line. If we divide values of F (obtained by calculation), by the area of the piston of the engine, we get the pressures per square inch of piston required for acceleration and retardation.

Example. An engine having a cylinder 12 × 24 inches and making 120 revolutions per minute, has reciprocating parts weighing 400 pounds. Required the pressure per square inch of piston due to the inertia of reciprocating parts at either end of the stroke.

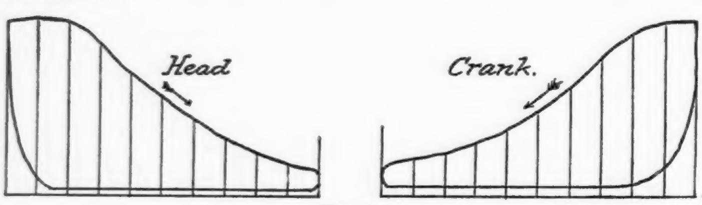


Fig. 4.

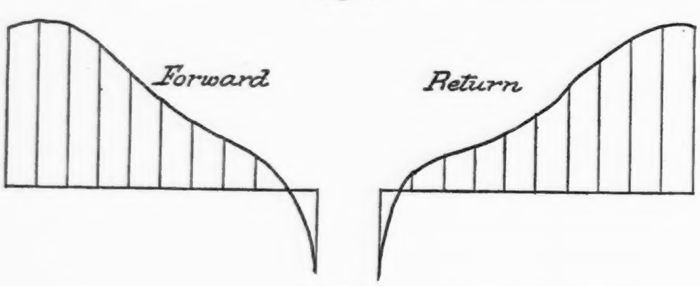


Fig. 5.

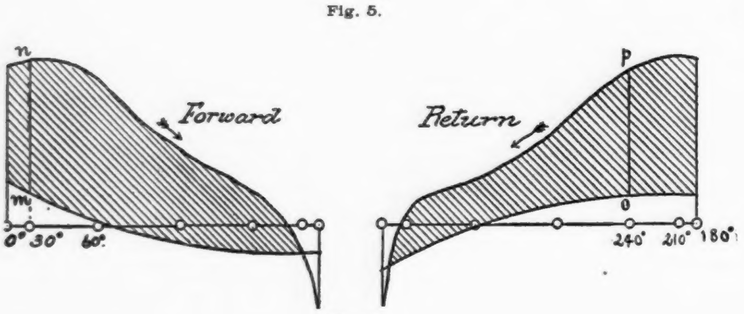


Fig. 6.

In this example we have $W = 400$, $r = 1$ and

$v = \frac{120}{60} \times 6.28 = 12.56$ feet per second, as the average velocity of the crank pin.

If we assume the length of connecting rod as six cranks, $n = 6$

$$F = \frac{Wv^2}{gr} \pm \frac{1}{n} \cdot \frac{Wv^2}{gr} = \frac{400 \times 157.8\,(1 \pm 1/6)}{32.2 \times 1}$$

$$F = 1960\,(1 \pm 1/6)$$
$$= 2287 \text{ at beginning of stroke and}$$
$$= 1633 \text{ at end of stroke.}$$

The area of the piston is 113.1 square inches; dividing F by this area, we have 20.2 pounds per square inch to be subtracted from the initial pressure of the indicator diagram, and 14.4 pounds per square inch to be added to the terminal pressure, on the forward stroke. On the return stroke, the 20.2 is to be added and the 14.4 subtracted. This is best shown in Fig. 3, which gives the cards for the forward and return strokes after this change has been made. If we assume the initial pressure as 90 pounds gage, the terminal pressure as 6 pounds, the cut-off being at one-fifth stroke, the cards will be about as shown. The net pressure at the beginning of the forward stroke will be 90 — 2 — 20.2, or 67.8

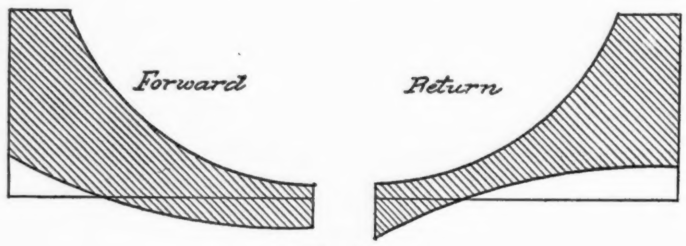


Fig. 3.

pounds (allowing 2 pounds for back pressure), and at the end of that stroke 6 — 2 + 14.4 or 18.4 pounds. On the return stroke the pressure will be 73.6 pounds and 24.2 pounds.

Intermediate values of F may be calculated from equation 2.

It is seen from the figure that the effect of this inertia force is to lessen the variation in the pressure which is transmitted to the crank pin; thus, by absorbing surplus energy at the beginning of the stroke and restoring it when the steam pressure is low, the reciprocating parts act as a sort of fly-wheel and help the real fly-wheel to make the speed more uniform.

Crank Diagrams.

Now that we have determined the pressures due to the reciprocating parts and their effect on the energy transmitted to the crank pin, we may proceed to find the effective pressures on the pin and draw a diagram. Let us begin with two indicator diagrams for the head and crank ends of the cylinder, as in Fig. 4. The upper or steam line of the head card is traced during the forward stroke at the same time as the lower or exhaust line of the crank card. Likewise, the steam line of the crank card and the exhaust line of the head card belong to the return stroke. Subtracting, then, the back pressures of one card from the forward pressures of the other, we have the diagrams of Fig. 5, which show the net pressures on the forward and return strokes. Diagrams similar to those in Fig. 2 are next drawn, showing the pressures due to the inertia of the piston, cross head and rods and are combined with the diagrams in Fig. 5, as has already been explained. Fig. 6 shows the result of this combination and the vertical distances on the shaded areas show the net horizontal pressures which actually reach the crank pin. If the work has been correctly done, the net areas of the two digrams will be the same as the net areas of the diagrams in Fig. 5. The small triangular areas below the line in both figures are negative and must be subtracted to give the net energy.

It now remains to find how far these pressures act to turn the crank. Fig. 7 represents the connecting mechanism of an engine and is in all respects the same as Fig. 1, except that now we are in search of pressures or forces instead of velocities. It has already been proved that at any instant the velocity of P : velocity of C :: OK : OC. Now in mechanisms the ratio of pressures is the reciprocal of the ratio of velocities. Therefore:

The pressure on P : the pressure on C : : OC : OK.

Draw PS to represent the pressure on the piston at this instant and CT to represent the pressure tending to turn the crank then, PS : CT : : OC : OK.

Therefore, to find CT lay off on OC, Os = PS and draw st parallel to CK, then will Ot be the proper length of CT, for:

Os : Ot : : OC : OK.

We are now prepared to draw the diagrams for the crank pressures. As the path of the crank is the semi-circle ACB, on the forward stroke, and BDA on the return stroke, we lay off in Fig.

8 the straight lines FG and MN, each equal to the semi-circumference rectified, or stroke × 1.57. These are divided into equal parts representing equal angles of motion of the crank, 30°, 60°, etc. By construction, as in Fig. 7, the corresponding positions of the piston and cross head are found and transferred to Fig. 6. To make this entirely clear, the different positions in Fig. 6 are numbered 30°, 60°, etc., to correspond to the crank positions in Fig. 8. We are now ready to plot the curves of crank pressures. Ordinates are drawn at the division points in both Fig. 6 and Fig. 8. The ordinate mn in Fig 6, which shows the net pressure at 30°, is measured off at Os in Fig. 7. The line st parallel to PCK is drawn, cutting off Ot, which shows the effective pressure on the crank. Ot is now laid off on Fig. 8 at m'n'. The other points in the curve Fn'G are similarly determined. For the return stroke, points are found in the curve Mp'N, as illustrated at op in Fig. 6, Ot' in Fig. 7 and o'p' in Fig. 8.

If these figures have been carefully drawn to scale, the areas

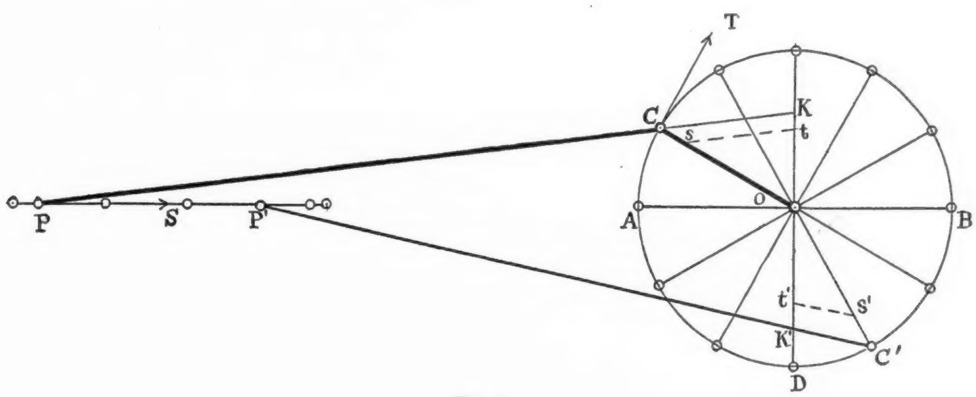


Fig. 7.

of the diagram in Fig. 8 should be the same as in Fig. 5 and Fig. 6. If the combined area of the two diagrams in Fig. 8 be now divided by their combined length, the quotient is the mean pressure FH = MR. Constructing the rectangles FHJG and MRSN, these represent the constant work by the engine and are equal in area to the original diagrams.

The shaded areas above the lines HJ and RS show the excess of energy received from the steam, the quantity called E in the article on fly-wheels*, and must be stored in the fly-wheel, the velocity of the wheel increasing from 1 to 2 and from 3 to 4. The shaded areas below the lines show the energy restored by the fly-wheel, equal in amount to that absorbed. The wheel

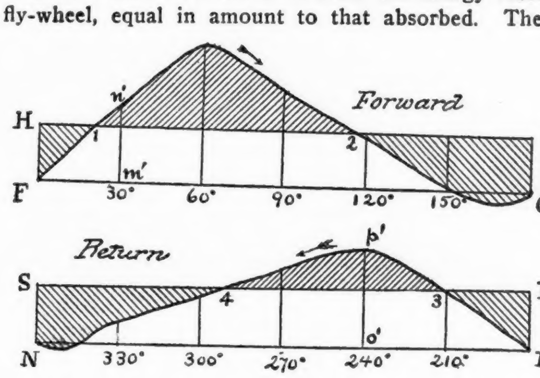


Fig. 8.

is thus retarded in turning from 2 to 3 and from 4 to 1. As drawn, these areas show the work of energy per square inch of piston and must be multiplied by the area of piston before being used in calculation..

From the figure it may be seen that the velocity of the wheel is greatest at 2 and 4 and least at 1 and 3, the speed changing twice in each revolution. The irregularity of the crank diagrams depends upon the time of cut-off in the steam cylinder, the ratio of crank and connecting-rod lengths and the weight and velocity of the reciprocating parts. On a high speed engine this latter weight should be small, while on a low-speed engine an increase in the weight of the cross head will frequently improve the running. It is always best to keep the piston as light as possible, since a heavy piston in the ordinary horizontal engine will wear the cylinder badly.

The effect of the inertia of the reciprocating parts on the stability of the engine and the various methods of counter-balancing cranks will be considered in another article.

* See MACHINERY, October, 1899, p. 58.

* * *

ABOUT ALUMINUM.

Aluminum is cheaper than all the common metals excepting zinc, lead and iron. Brass, tin, copper are of approximately the same specific gravity, and in comparing their costs we usually think only of their relative cost per pound; but aluminum is entirely in another class. It takes only one-third of a pound of aluminum to take the place of one pound of these metals, and the proper basis of comparison here is to compare the price of one-third of a pound of aluminum with that of one pound of brass, etc. The comparison, therefore, stands as follows:

One-third pound of aluminum	$0.11
One " " brass	0.15
" " " copper	0.17
" " " tin	0.30

The next great improvement, after that of the fall in price, has been in the successful manufacture of light, strong alloys. This has been a subject at which metallurgists have worked hard and long, and their labors are bearing fruit in abundance. Pure aluminum has many resemblances to pure copper. Take away the red color of copper, and its softness, malleability, toughness, silky fibrous fracture are almost exactly duplicated by aluminum; but they are both soft, rather weak metals. Five per cent. of aluminum, silicon or manganese or 30 per cent. of zinc, added to aluminum, make strong metals as rigid as bronze yet only one-third as heavy. Such light, strong, good casting and machining alloys have a large field of usefulness. One, for example, made by the Delaware Metal Refinery, of Philadelphia, is a hard white alloy, specific gravity 3.1, melts clean, runs fluid, makes beautifully sharp and perfect castings, turns and machines like the finest brass, polishes well, and, to conclude, is fully as rigid and strong as gun metal or the best of the ordinary bronzes. This alloy is principally of aluminum and zinc, and sells at the same price per pound as pure aluminum. The field of application of light alloys with such properties to light-running machinery, portable apparatus, vehicles, instruments, etc., is extensive, and the next few years will see its use very general for such and similar purposes.

Electric conductors can now be laid more cheaply in aluminum than in copper. Pure aluminum has over 60 per cent. the conductivity of pure copper, and is fully as strong and resistant to atmospheric influences. It is therefore only necessary to take an aluminum wire one-fourth as large again in diameter as a copper wire (giving a little over 50 per cent. more section) to get equal conductivity. Such a wire weighs one-half as much as the copper wire it replaces, and costs only two-thirds as much. Over 500 tons of aluminum were used for trolley-line feed wires last year and probably double as much will be used this year. Fifteen years ago 2½ tons of aluminum was the output of the whole world for one year.

Aluminum can be rolled out to $\frac{1}{2000}$ of an inch in thickness, and then beaten out to $\frac{1}{40000}$ or even $\frac{1}{70000}$ of an inch. As thin sheet it has found some application in place of cardboard, for business cards, etc., but as leaf it has entirely superseded silver-leaf in decorating. This leaf can, moreover, be ground to powder, and in this condition is used by printers for silvery printing, and as a paint. For the latter use it is simply mixed with a varnish, like ordinary bronzing powders, and has already proven its beauty and utility on Uncle Sam's letter-boxes.—Journal of Franklin Institute.

* * *

A patent (651,356) has recently been granted on a die for forming twist drills from cylindrical blanks. The principle involved is analogous to that of broaching, the blank being forced longitudinally through the die which has inwardly projecting cutters of the proper shape for forming the grooves. As the blank is forced through, it is at the same time rotated sufficiently to give the flutes the required twist.

AN OLD-TIME SHOP.

N. W. Fay.

"I was taken back to a certain New England shop."

THE editorial, "An Object Lesson," published some time ago in the columns of your paper, and dealing with some of the old country shops and their adherence to old-fashioned methods, was to me a most interesting one. I have read and re-read it and each time I got well into the article I had a slight feeling of homesickness, for I was taken back to a certain New England shop where I spent several years in the early part of my mechanical life. As I read of the old-fashioned features of the shop described in the article and noted its absence of up-to-date tools and methods, its lack of proper light and cleanliness and want of modern features in general, I could almost believe that this was the identical shop in which, as a youngster, I went on many bootless errands in quest of time-honored left-handed wrenches, round squares, and where, as I became a little older, I had the pleasure of sending other young and equally guileless boys after the same useful tools. But as I again peruse the article and read of that unexpected and unrequested raise of ten per cent., of the fair and generous treatment accorded the workmen, and of the general good feeling existing between management and men, the resemblance ceases and I am forced to believe that the shops described in the editorial and the one in which I used to work are two altogether different places.

To-day, when we have so many new shops and so many old shops modernized, it seems almost like a visit to some strange land to go into one of these thoroughly old-fashioned establishments where the same tools have been used and the same methods have been in vogue for perhaps two generations or more.

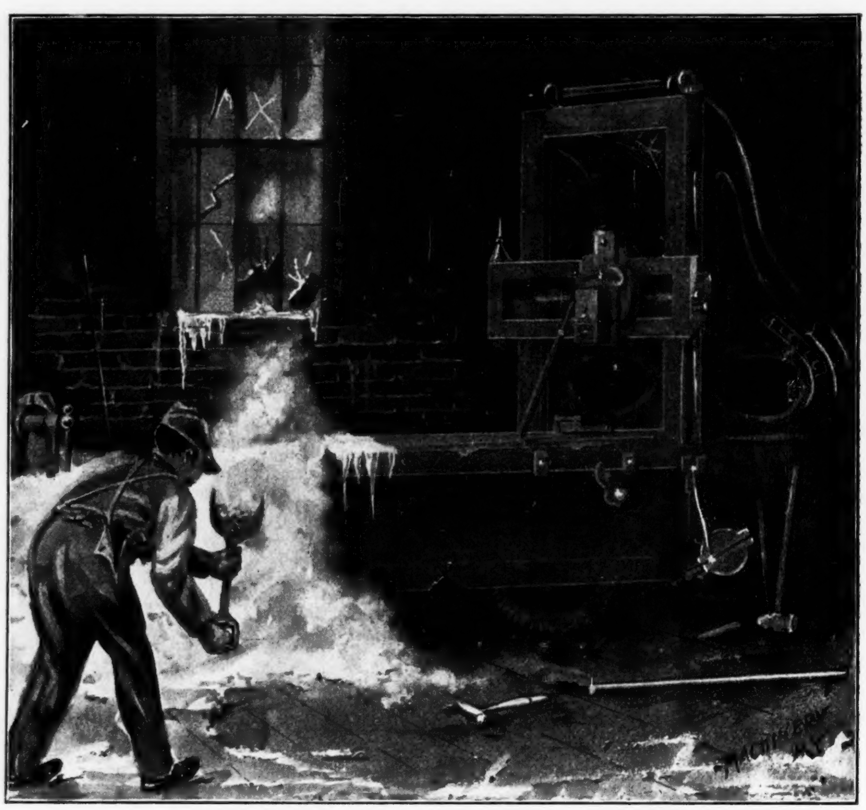
I wonder how many boys serving apprenticeships in up-to-date shops, handling the best of tools and coming in contact with workmen from all parts of the world, realize just what conditions prevail in certain old-fashioned country shops where methods and systems have remained practically unchanged for many years; where almost the entire force of men is and has been drawn from one particular locality, that in the immediate vicinity of the shop, and where, in consequence of this lack of outside workmen of varied experience, there is little tendency towards the adoption of up-to-date shop ideas. I do not mean to say that because a shop is located in a back district, and has a history extending back into the dark ages, it need necessarily be behind the times in methods; but the one in which I worked was decidedly so and it has been under my observation for so long a time that I cannot fail to see the marked indifference or even antipathy with which the management has greeted any and all proposed innovations.

I believe that the older and less efficiently equipped shops have turned out many of our best workmen; one reason, perhaps, being that the poorer the tools a man has to work with, the more skilful he must be to produce good work. Another reason is, I think, that where comparatively little system prevails each man works more upon his own lines, possibly carrying a job through all its stages with little or no direction from a foreman. In this way individual ingenuity and ability have far greater opportunity to assert themselves than is the case where a foreman directs each operation.

But there are different kinds of old-fashioned shops as well as modern and in the one which fell under my observation, the antique was decidedly overdone. Not but what it was, and is still, I believe, an excellent place to serve an apprenticeship if a boy has the mechanical instinct within him and is energetic enough to keep out of some of the ruts into which some older men have fallen, and into which a lazy and thoughtless youth might easily get. Here the management, both in office and shop, is woefully negligent of its own and its employee's interests. First-class work is not compulsory and little encouragement is offered for man or boy to do good work, except the satisfaction a true mechanic feels in the knowledge of labor well performed.

We all know that it is in some of the older and poorer equipped shops that surprises are to be expected in the way work is handled, many very interesting jobs being done which seldom come to the attention of most of us, owing to the fact that visitors as a rule spend most of their time in larger and better known shops; but the surprises that I run into each time I visit that New England shop of my youth are of a kind that should be shelved, being most expensive and of little interest to any one except as showing how work ought not to be done.

Being well acquainted with the general characteristics of the place and therefore being on my guard, I manage to get well into the shop without serious accident, avoiding many pitfalls in the way of old scrap, piles of castings, lengths of shafting, etc., which beset the path of the uninitiated. I find most of my old friends safely intrenched in their accustomed places and many of them seem to be at work on the same job which they had in hand at a previous visit. Upon inquiry, however, it proves to be a different one, although feeds and speeds are such that one might be pardoned for asking the question; but some castings are pretty hard, you know, and this is not a high pressure shop, anyway. To be sure, some of the men are running two lathes, which is as many as they would be expected to run in some more modern shops; but cutting speeds are such that no more energy is required in their operation than would be needed to run one lathe in one of the latter places.



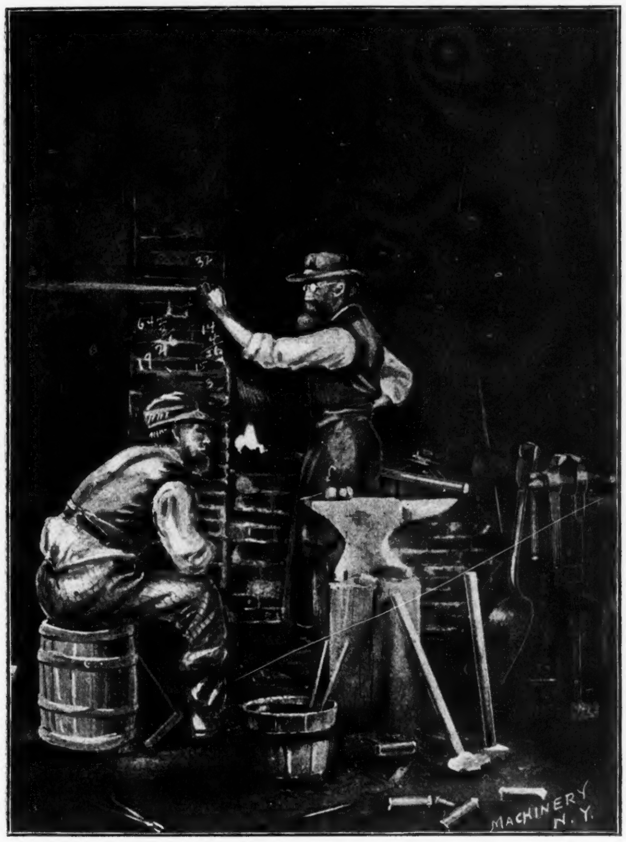
"I wonder how many boys in up-to-date shops realize what conditions prevail in certain old-fashioned shops."

One man is turning up a lot of collars. He has been turning for some time and will continue quite a while longer on the same job, and each time he drives out the arbor and drives it into another collar, he goes on a search for a block and a sledge which some one has borrowed and which, if he has good luck, he finds after a little time. An arbor press would pay for itself in a very short time, but it doesn't have the opportunity. Arbor presses have not been heard of in some parts of this shop, and a

man has to have a little time to walk around any way, you know.

There are a great many short pieces of iron and steel used here. Out in the blacksmith shop I find an old acquaintance cutting them off with the aid of a helper. For a good many years he has spent several hours each week cutting off these pieces; in fact, when his other work is well caught up, he has a sort of stock job to fall back upon. Of course, they are well cut off, pretty nearly to length, a little more or less as the case may be; and after the corners are knocked down and the ends are set up a little, they are sent into the shop, where a man in a lathe has only to face off from 1-16 to 1/4 of an inch on each end to make them nice and square. "It seems to me, you fellows ought to have a power hacksaw out here to cut those pieces off in. It would save a lot of stock, take very little of your time to look after and the machining of them would be a much easier and cheaper operation." "Don't say a word 'bout power hacksaws; I wouldn't have anything to do mor'n half the time, if 'twan't for them same pieces to cut off."

They make a good many small hand wheels at this place and carve them out in a lathe with a round-nose tool, and approach almost any shape of rim but the right one. It is an ideal job for a forming tool, and a couple of dollars more or less spent in making one would come back in as many days with interest, and a first-class job be always guaranteed; but anything in the way of special tools savors of heresy and is barred out, and thus it goes throughout the whole system. Time thrown away, stock wasted, and money lost just for the sake of upholding the principle of doing things exactly as father, grandfather and great-grandfather did.



"Don't say a word 'bout power hack saws."

Methods of handling heavier work are fully as antiquated as those used for lighter work; planers and lathes doing many jobs which should be put onto other machines. One example noticed was the facing off of small bosses on a lot of ugly-shaped castings that should have been machined under a drill press with cheaper workmen.

Judging from occasional notes in our mechanical papers regarding the extremely conservative gentlemen who manage some foreign workshops, I should imagine that the arrangements for lighting and heating this establishment would find great favor in their sight. During the winter months the man nearest the stove is all right if he revolves occasionally, thus neutralizing the tendency to melt and freeze; but his unfortunate shopmates who are too far removed from the heat center to receive any benefit therefrom, are to be pitied. The ancient lamps or glims used for lighting (?) leave much to be desired. They are practically of no service whatever except to assist the men somewhat in making out their time cards. A glimmer here and there about the shop may indicate that a man is in that vicinity, but it is doubtful if he is accomplishing much in the way of work, unless he has a job running which will take care of itself. When summer is at hand, however, the subject of artificial lighting can be forgotten for a few months.

At this writing all the tool makers, save the mark, employed by this concern are busily engaged in patching up an economical management's latest acquired antiquity, endeavoring to give it a new lease of life, its last one having expired some years since. This machine has done good service for many years and now should be given a prolonged rest and the space it fills occupied by a more up-to-date tool. The manager, however, is busy outside directing a gang of laborers in the operation of getting another piece of machinery into the shop and has no time to think of purchasing any more tools or to consider how to use to better advantage those which he has. He has a foreman who is perfectly capable of shifting his machinery for him as well as looking after the shop in general, but this manager thinks he can earn more money for his concern by running around the shop, in doing the work of less expensive men (in a much less satisfactory manner) than he can by looking up new work and investigating what better shops are doing and what facilities they are employing for more rapid and economical production.

* * *

HEAVY ENGINE PROPORTIONS.

We recently heard the view expressed by a prominent consulting engineer, that the tendency toward heavy shafts and large bearings and other wearing surfaces in present engine practice is abnormal, and that there is no occasion for so great an increase in the sizes of parts as is now taking place. This change is more conspicuous in the shaft sizes than elsewhere. Formerly the best shafts were of wrought iron and they were not more than two-thirds the diameters of present shafts, which are often of oil-tempered steel. Larger shafts mean larger bearings, more friction, and, according to this engineer, when carried to an extreme no more satisfactory performance than with smaller sizes. It is to be noted, however, that this tendency is to be found among English firms as well as among our own, which would indicate that there is good ground for the custom. In a recent number of "The Engineer," is an article by Charles Day, which discusses this point, with reference to generator engines that have both armatures and flywheels on their shafts.

He says: "Remembering that, in addition to the flywheel, the heavy armature of a dynamo is fixed on the crank shaft, it is evident that a stronger shaft and larger bearings are necessary than if only a flywheel were required to be carried, but in looking into the list of sizes adopted, it will be seen that both the bearing and shaft sizes are greater than are necessary for the mere carrying of the additional weight. American designers say that the greatly increased strength is necessary in consequence of the possibility of the downward forces due to gravity being greatly increased by unbalanced magnetic pull on the armature, as, if by wear, imperfect setting, or any other cause, the center of the armature is below the center of the magnet poles, the magnetic attraction acting downwards may be greatly in excess of that acting upwards. The strength of the shaft and the area of the bearings must, therefore, be such that this additional weight, as it may for simplicity be termed, can safely be carried. The amount of this magnetic pull may be very considerable, and a prominent electrical firm give it as 18 tons for a deviation in centers of 1-16 in. of a 600-kilowatt generator. Remembering that the dynamo frame is often carried independently of the engine frames, 1-16 in. deviation is certainly the very lowest that should be reckoned on, and twice this amount would not be unlikely to occur in practice. At one station this unbalanced magnetic pull between the armature and the dynamo frame on one occasion became so great that, combined with the torsion forces, it caused the breakage of all the bolts holding down the dynamo frame."

* * *

It is often said that the continual re-working of wrought-iron causes its deterioration. It is more probable that this is due, not to the re-working, but to the impurities in the fire that are absorbed by the metal during its manipulation.

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SEPTEMBER, 1900.

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1899.		1900		1900.	
October	17,500	February ...	20,500	June	27,500
November ..	17,750	March	25,000	July	22,000
December ..	18,500	April	21,500	August	21,500
1900.		May	21,500	September ..	21,750
January	20,000				

The index for volume six is ready for distribution and will be sent to any subscriber who applies for it.

* * *

By an error in the article on the Vincennes machinery exhibits at the Paris Exposition, which appeared in the August issue, the Prentiss Tool & Supply Co. are credited with occupying Space 1 in Block III., whereas it is actually occupied by Prentice Bros. Co., of Worcester, Mass., with an exhibit of their lathes and vertical and radial drills.

* * *

Freight locomotives have become so heavy in many instances that the demands on the firemen are more than one man can stand. On the C. R. R. of N. J., two firemen are put on the new heavy locomotives recently added to the road's equipment. The solution of the firing question on heavy freight engines, will undoubtedly be that of mechanical stoking, in which a machine will do the work under the management of the fireman, who will thus be relieved from his present arduous situation and promoted to that of a machine operator. Whether this condition will mean a change in the wage basis will only be settled when the actual conditions are realized. It is probable, however, that in economical locomotive stoking, mechanically considered, the skill required of the operator or fireman to get proper results will mean the maintenance of the present wage rate, if not an addition to it.

* * *

WHAT IS A TRADE SECRET?

"It is a misdemeanor in Germany to purloin trade secrets. A machinist was recently sentenced to a term of imprisonment for entering the employ of a firm for the sole purpose of becoming familiar with their work methods and processes, with the intention of making his real employers cognizant of these "points" in manufacture. Not only was the actual offender committed to jail, but also those who were using him as their tool."

The above is the substance of a recent press report commenting on the industrial conditions existing in the German Empire, the comment being accompanied with an unqualified endorsement of the law and the justice of the guilty parties' punishment. While in this instance the facts, as given, allow little sympathy for the perpetrators of such a sneaking trick, we cannot but feel that such a law in application would likely be subject to the gravest abuses, as its correct interpretation would, in many instances, be an impossibility. The question is: What constitutes a "trade secret," especially in the machine business? Are there really any trade secrets worthy of the name? Has the possessor of a trade secret any guarantee that he is the only one knowing its application? To the latter, we think not. There is abundant evidence that some processes of manufacture are, in their essential nature, as ancient as civilization, yet not uncommonly, the methods are considered in the same light as a trade secret although the "secret" has been transmitted from father to son or apprentice for generations.

We believe that there is usually little fear for the integrity of a business because of the purloining of its secrets of manufacture, if any exist. The man who has so little brains that he must need to steal the ideas of others, will scarcely be able to become a serious competitor in business. An imitation is rarely as good as the original.

* * *

TRADE CIRCULARS.

There are no handsomer publications of any kind than many of the catalogues issued in the machine trade. The finest halftone engravings are used to illustrate the text, the typography is the best that skilled printers and compositors can produce and the press work is not excelled, even in the expensive "editions de luxe" of the leading publishing houses. Machine builders and manufacturers apparently vie with one another in their efforts at producing a favorable impression on the public, through the medium of the printer and the engraver.

While the improvement in the outward appearance of these catalogues has been very marked during the past few years, there is not always an improvement in what the manufacturers have to say about their tools. Stereotyped and meaningless phrases still abound and with these catalogues stripped of their handsome typography there is, in many cases, very little information that the mechanic wants to obtain. There are, of course, many and notable exceptions to this condition, but a careful examination of trade literature will show that such a state exists to a greater or less extent.

One or two illustrations will emphasize the fact that we have just stated in a general way.

When a manufacturer makes agricultural machinery he puts on plenty of bright paint and varnish, gives some of the parts a cheap polish to catch the eye and then talks long and loud about the expensive materials, superior workmanship, great capacity, etc., until the farmer is duly impressed and places his order.

The same is true to a greater or less extent in selling to other classes who know nothing about machine construction. At one time it was the custom for printing-press builders to make a so-called "country" press to sell at a low figure, because country printers have but little money to spend and if they buy presses at all, it must be at rock-bottom prices. Another press was also made, called a "first-class" or "book" press that was substantially the same machine as the other, but which was intended for city printers who have more money (?) than their country brothers, and so could be "worked" to pay a higher price. True, this press had generally a few "extras" in the way of attachments and a little nickel plate; but there was nothing commensurate with the increased price at which it was sold.

When the printing press agent met the city proprietor, he replied to the question as to what was the difference between the two machines by talk about "superior materials," "increased weight," "expensive attachments," etc., and generally sold him this type of press.

Now, this method of representing and selling machinery has not been confined to farmers' and printers' machinery. It is used more or less in all other lines of machinery, machine tools included. Catalogues that go into the hands of men that know all about machinery and can appreciate the good points of good machinery are often filled with the glitter resembling the bright color of the farmers' machinery and the rubbish that was served to the city printer. Mechanics look in vain for the information that they want about a tool.

Only recently a case in point came to our attention. In a New Jersey shop is a machine tool of a make that several years ago was well known. The claims made for the tool were practically those advanced for other similar machines and it appeared to have many points of convenience besides. After it was sold, however, it was found to be of the cheapest construction. As an illustration, the driving-cone shaft had no collars to take the end thrust, this being provided for by annular grooves turned in the journals, into which the babbitt was run when the cheap, babbitted boxes were poured, with the shaft in place.

It is evident that information should at least be given to enable one to distinguish between work of this character and that turned out by our better shops. Let those who turn out cheap work indulge in phrases like "long and generous bearings," "great strength and superior workmanship," if they will; but let those who are putting out a superior article present specific specifications so that one will know that the article is superior and that he is obtaining what he wants.

It is common, in fact, almost invariable, to give the main dimensions of the essential parts of machines, but this is not enough. If a lathe is manufactured and tested so that it is known that the spindle will run true within .0005 inch; that the lathe will bore within .002 inch per foot and is accurate in other respects in proportion; and if babbitted boxes are used, carefully pened, bored and reamed, because, for example, it is believed that they are less liable to scratch the spindle than are bronze bearings, these points ought to be stated. They are the points concerning which people who buy machine tools desire more light.

Then, as to the matter of details. A man wants the opportunity to pass his judgment upon these before he purchases and if there are any interesting features of this kind, they ought to be shown fully and clearly. Some hold that such publicity enables copyists to profit by the work of others, but we believe there is more fiction than truth in such a supposition. When a machine once leaves a factory, copyists have their opportunity and can make use of it if they wish. When details are kept "dark" an incentive is offered to find out what is going on, and copyists can do it if they desire. But if extreme publicity is given to important details, the public at large knows about them; they know who are the originators, to whom credit is due and, on the principle that no copy is as good as the original which may not always, but generally does hold true, they will support the originator rather than the copyist.

Our suggestion for trade circulars, then, is that along with the improvement in press work and typography there should also be a change in the quality of matter presented. It should be more specific, more in detail and should tell those things that mechanics, rather than non-mechanics, would investigate if they had the opportunity of seeing the machine itself before buying.

* * *

A SEVERE CASE OF "HOODOOED" MACHINERY.

While this is not the age of superstition, we are invited to believe by a newspaper report of some difficulties that beset the "Deutschland" on her second voyage, that malign spirits even now trouble themselves with the concerns of humanity. One of the minor officers committed suicide on the second day of the trip.

"Following the suicide, which all on board regarded as an ill omen, the ship's machinery, which had worked so perfectly during her initial record-breaking voyage, went awry. On August 1 a piston rod broke, following this the ball bearings became overheated and some of the heavy machinery got out of plumb, making the ship list, so that she plunged around in a circle for several hours."

Of course, vulgar unbelievers might insist that defective material had something to do with the breaking of a piston rod (although as a matter of fact it did not break), but nothing less than spirit influence could account for a vessel having the "blind staggers."

* * *

MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—11.

SHAPING MACHINES.

W. H. Van Dervoort.

Fig. 96 shows a side view of a planer head. This same general form is used by all builders on both the planer and shaper. It is nothing more than the compound rest on the lathe having in addition the tool box and apron. The cross rail corresponds to the carriage on the lathe. It is a rigid girder that contains the cross-feed screw, the vertical feed rod, and upon which the saddle travels, it being securely gibbed to the cross rail. The swing

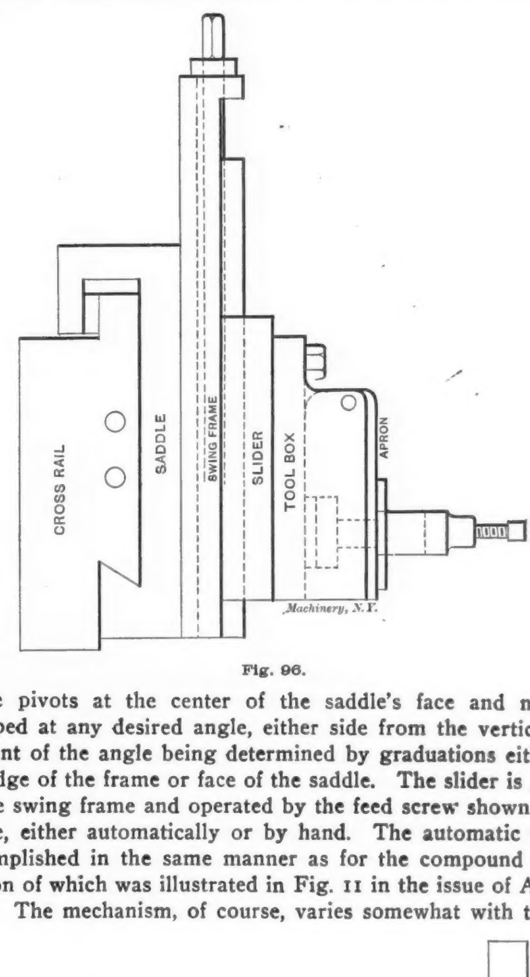


Fig. 96.

frame pivots at the center of the saddle's face and may be clamped at any desired angle, either side from the vertical, the amount of the angle being determined by graduations either on the edge of the frame or face of the saddle. The slider is gibbed to the swing frame and operated by the feed screw shown in the figure, either automatically or by hand. The automatic feed is accomplished in the same manner as for the compound rest, a section of which was illustrated in Fig. 11 in the issue of August, 1899. The mechanism, of course, varies somewhat with the different builders. The tool box is pivoted to the slider and has a limited amount of adjustment, each side from the center, being clamped rigidly in any desired position by the lock bolts shown. The apron, which fits neatly in the tool box, is pivoted to the box at the upper forward corner, thus allowing it to swing outward on the return stroke and prevent the tool from dragging heavily over the work surface. The tool post is secured to the apron. The office of the tool box is to allow the tool to swing

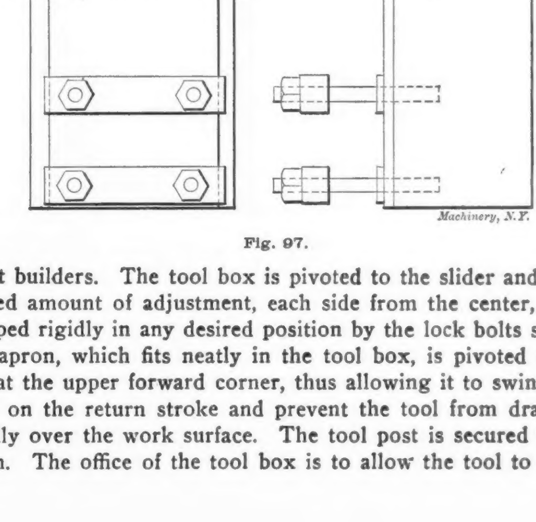


Fig. 97.

out from the work on the return stroke when machining side surfaces. It is evident that if the tool post were secured to an apron pivoted directly to the slider, the tool would swing straight out on the return stroke which would be all right when machining top surfaces. If, however, a side surface were machined, the tool in swinging straight out, would drag up over

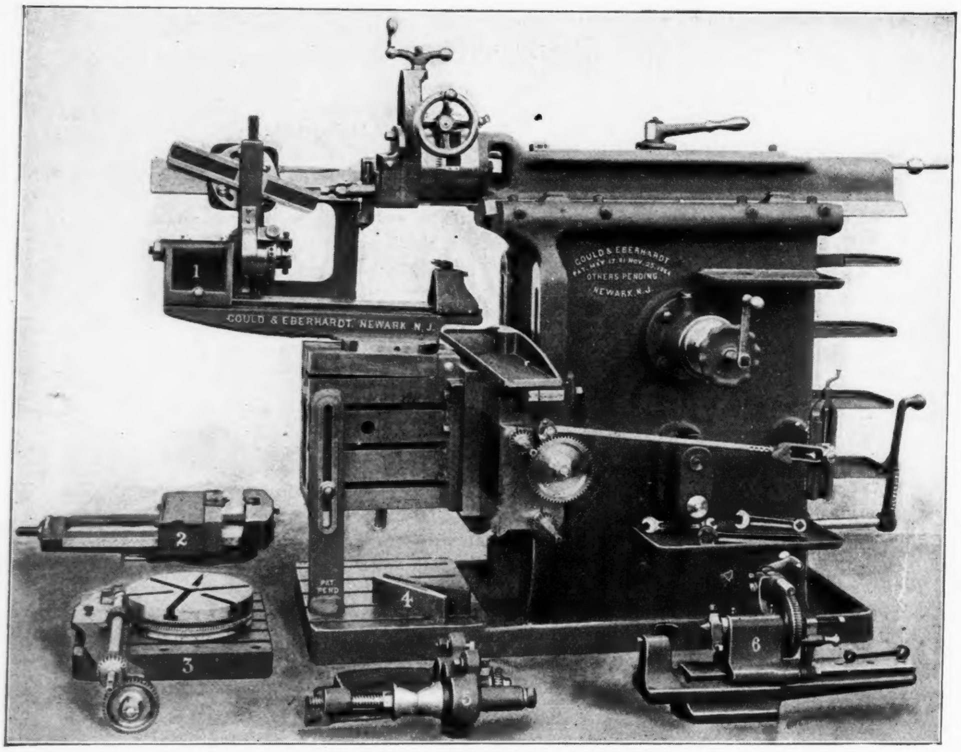


Fig. 98. Shaper with Various Attachments.

the surface planed, injuring the tool and marring the surface. When, however, the apron pivots to a tool block that can be inclined somewhat away from the work surface, it is evident that the point of the tool will, upon the return stroke, swing out

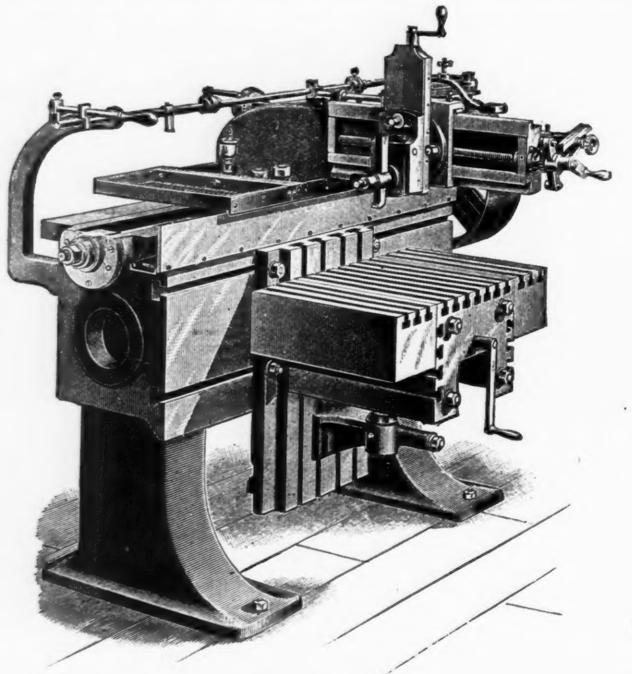


Fig. 99. Richards' Side Planer.

from the work; but if the top of the tool box be inclined toward the side of the work, the tool will swing into the work surface, causing trouble. It is, therefore, necessary to swing the box in the opposite direction when changing from one side of the work to the other. The tool clamping device may be an ordinary tool post as used on the lathe, but it is more commonly a pair of clamps, as shown in Fig. 97.

What is known as the standard shaper is of the column or pillar pattern, one design of which is shown in Fig. 98, with several shaper attachments (to be described later). In this machine the upright is called the column. The cross rail is gibbed to its front face and is adjustable vertically by a suitable elevating screw. The box or knee is screwed to a saddle which moves over the cross rail. The ram which carries the tool head is gibbed in the top of the column. The tool head is in every way similar to the one described above, the swing frame being pivoted to the end of the ram. In the example shown, the swing frame is rotated by means of a worm gear and hand wheel, which enables its operation while the machine is in motion, a most convenient method of shaping out concave surfaces.

In all shapers the ram is actuated by one of two methods. The geared method provides for a rack and gear drive similar to that used in operating the table on the planer. It is simply a geared reduction, the quick return to the ram being accomplished by either the use of a smaller backing pulley, or higher belt velocity for the return stroke. This drive was illustrated in Fig. 88, article No. 10. It is little used in the smaller shapers. The other method is known as the crank drive, in which a crank or its equivalent, operated by a suitable system of gears, transmits the motion to the ram. The use of the simple crank drive has been superseded by crank drives which involve a quick-return motion. With the simple crank motion, not only is the time occupied on the return stroke of the ram equal to that on the forward stroke, but the relative velocity of the ram varies greatly between the beginning and the end of the stroke, being much more rapid at the middle than at the ends. With the quick-return motions, however, it is intended to reduce the time during which the ram is on its return stroke and thus give more time for the forward or cutting stroke, and also to average up as much as possible the relative velocity of the ram at the different

Fig. 100. Morton Draw-cut Shaper.

portions of its forward stroke. In all cases the power is communicated to a shaft, usually by a belt running on a stepped cone, causing it to rotate at a uniform rate of speed.

In Fig. 102 is shown the mechanism commonly known as the slotted or vibrating link. P is a pinion receiving motion from the belted cone at a uniform rate of rotation, and gearing with

the gear G. The link M M pivots at the point L and carries at its upper end the rod R which connects with the ram at H. A block B is fitted nicely in a slot S in the link and is carried on the pin I which projects from the face of the gear G. The path of the pins is a a, the block B moving up and down in the slot and causing the link to vibrate about L through the limits y y, carrying with it the rod R and the ram. If G rotates in the direction shown by the arrow and the tool end of the ram is at K, then the forward part of the stroke occupies that portion of G's rotation indicated by the angle x and the return portion by the angle y. It is, therefore, evident that the return stroke occupies much less than one-half of the revolution of G. An analysis of the mechanism shows the motion of the ram to be much more uniform than with the simple crank, the velocity being faster at the beginning and end of the stroke and slower through the middle portions. As more of the time of each revolution is occupied by the cutting stroke with this quick return than with the simple crank motion, the velocity of the cut will be lower and more uniform, thus enabling a greater number of strokes per minute to be taken than would be permissible with the simple crank motion. By carrying the pin I toward its center of rotation, the length of the stroke may be shortened by any desired amount.

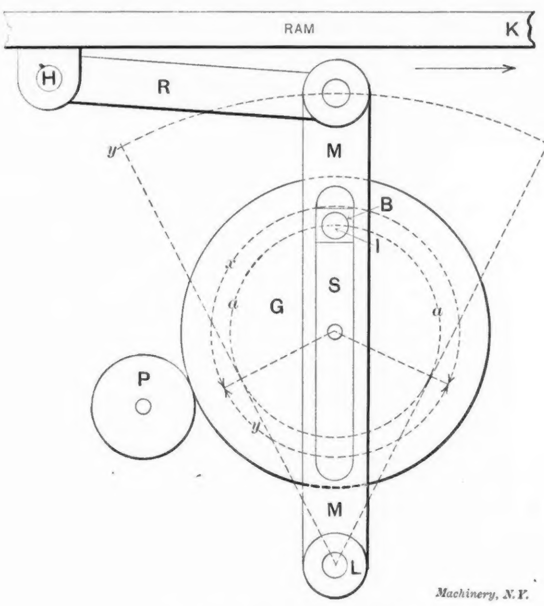


Fig. 102. Slotted Link Motion.

The Whitworth quick return motion, as illustrated in Fig. 103, is very largely used for shaper drives. Referring to the figure, P is the pinion that transmits the power to the gear G, causing it to rotate at a constant rate of speed. G rotates upon a fixed stud B of large diameter. The crank A is fixed to the shaft C which has a bearing in B eccentric to its center. A pin D is fastened in the face of the gear G and engages in the slot I in the back of the crank, thus causing the crank to rotate with the gear. A pin X carries the end of the connecting rod R which transmits the motion to the ram at Z. The path of D's rotation is about the center of B, and the path of X is about the center of C. When the crank is in the position shown, the lever arm D C is minimum and since D rotates at a uniform rate of speed, the velocity of X will be greater at this point than at any other point in its rotation. When D reaches the position D′, the lever arm D C becomes maximum and the pin X is moving at its slowest rate. While X is going from W to W′, in the direction of the arrow, the ram Z is making its return stroke and the pin D has rotated from V to V′ or through somewhat less than one-half of its revolution. The forward stroke is made while R moves from W′ to W and D from V′ to V. It is evident from the above that more time is occupied on the forward than on the return stroke.

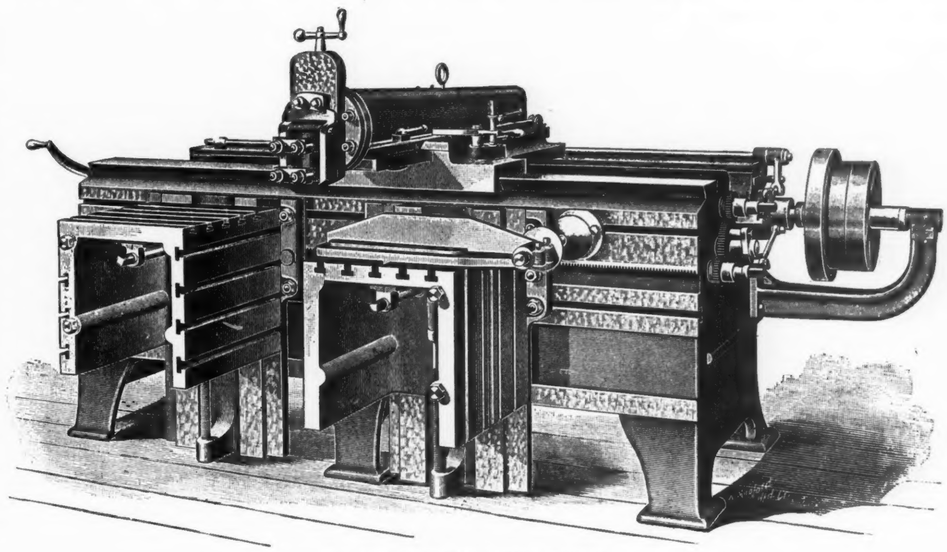


Fig. 101. Traveling Head Shaper.

A form of shaper well adapted to the machining of long pieces of work is shown in Fig. 99. In this tool the bed, which is long, carries the knee on its front face and the arm which corresponds to the ram on the pillar shaper is given a motion lengthwise of the bed, the tool head being fed automatically in or out on the arm. This machine differs from the open-side planer illustrated in the preceding article in that the tool moves over stationary work, whereas the work moves under the tool in the open side planer. On that which is known as the movable head shaper, illustrated in Fig. 101, the work remains stationary and the ram is mounted in a saddle gibbed to the top of the bed and fed over the work. Shapers of this class are most excellently adapted to the machining of widely separated surfaces on heavy pieces of work.

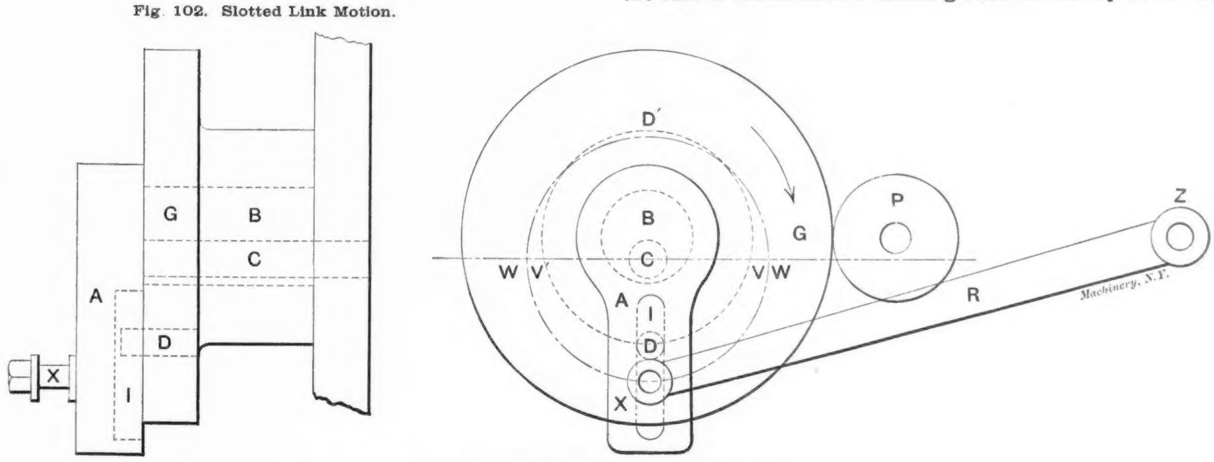


Fig. 103. Whitworth Quick Return Motion.

In the classes of shapers above illustrated the cutting stroke is

the outward or push stroke. In the Morton or draw-stroke shaper shown in Fig. 100, the reverse is the case, as the tool cuts on the inward or draw stroke. This tool has been very successfully used on heavy work and long strokes, and has been widely modified by its builders to suit special conditions. The head alone, attached to a suitable knee plate and driven by flexible shaft, rope transmission or electricity, is quite extensively used as a portable shaper to be clamped to the work that is to be machined.

* * *

THOMAS BLANCHARD, INVENTOR.*

ANECDOTES OF ONE OF THE LEADING MECHANICS OF THE CENTURY.

A modern French writer has said that the invention of the lathe, though lost in the prehistoric age, was an event of the greatest importance in the history of humanity, and certainly was for our ancestors the point of departure for a new era in our civilization. In its simplest form—a form in which it is still used in India—the lathe consists simply of two upright posts each carrying a fixed pin or dead center between which the work to be operated upon is caused to revolve by an assistant pulling alternately the two ends of a cord passed around it. A tool, held firmly on a bar which forms a rest, attacks the projecting parts as the work revolves towards the operator. An improvement of this primitive and simple device was made in Europe, and was in common use there until the end of the eighteenth century. It consists of two dead centers carried by "poppets" which are fastened to a bench, but are adjustable, within the limits of the length of the bench, to the length of the work. In this form the turner has no assistant, but rotates the work alternately towards and from him by means of a cord wound two or three times around the work, one end of which is fastened to a treadle operated by his foot and with the other end fastened to a spring-lath or pole fastened to the ceiling. This lath has immortalized itself by giving its name to the lathe, and has almost entirely disappeared from use. Though the dead-center lathe has disappeared from use, and has been replaced by an infinite variety of most ingenious mechanism, yet all mechanics will admit, within its limts, the dead-center lathe offers a steadiness of support and freedom of rotation which more modern designs seldom equal and never surpass. Though a considerable variety of work was done upon this simple form of the lathe, yet one invariable principle controlled its action—a vertical cross section of any point of the work was always a circle concentric with the axis of the lathe.

Any variation from this principle was not possible until the invention of the eccentric lathe by Thomas Blanchard, in 1819. This ingenious device may be said to have wrought a complete revolution in that branch of wood-working to which it appertains. Its first extended commercial application was for the making of lasts, but it is also used for the shaping of more difficult forms, such as gun-stocks and axe-handles.

If a pattern is placed in a lathe, and the material to be turned placed with its axis of rotation similar to that of the pattern, and if a guide pressing on the pattern directs a wheel with cutters to operate on the rough material over a surface like the pattern as guided, a perfect representation of the pattern will be produced on what was rough material, simply by the cutters chipping away all the rough material outside of the axis of direction—in other words, all the wood on the rough material outside of the pattern. This is the principle upon which this machine is constructed.

Thomas Blanchard, the inventor of the eccentric lathe, was born at Sutton, Mass., June 24th, 1788. His original American ancestors was one of a body of thirty Huguenot families who, about 1710, fled to Massachusetts, and was granted by Governor Joseph Dudley a tract of land in what is now the towns of Oxford and Sutton, in Worcester county. After about twenty years the settlement was broken up by the Indians, but subsequently the settlers returned. The father of Thomas Blanchard was a respectable farmer, who never gave any indication of mechanical genius, and the son seemed altogether misplaced, for he had no taste for farming, and there was nothing in the entire district to call out his inventive faculties. He received the ordinary common school education, but was accounted a dull boy, an impression no doubt largely due to an impediment in his speech, and to the fact that all his faculties seemed concentrated upon mechanical instruction. He was noted, as a boy, for his efficiency in the New England accomplishment of whittling, making wonderful wind-mills and water-wheels with his knife. When thirteen years old he made an apple-paring machine, with which, at the "paring-bees" held in the neighborhood, he could accomplish more than a dozen girls. When he was eighteen years old, an elder brother started, in a neighboring district, a factory to make tacks by horse-power, and he employed the youth to head tacks, which had to be done, one by one, by means of a vise. The boy was no sooner among the machinery than his dormant genius was aroused, and before many months he had constructed a machine by which he turned out 200 tacks in a minute, and more perfect in form than those made by hand. This machine he afterwards modified, so that it made 500 tacks in a minute, and experts assert that it is not capable of any further improvement, for it is the machine used to-day. He worked at tack making for some years, and then sold his patent for $5,000 and turned his attention to the improvement of gun-barrels.

On the Blackstone river, not far from his brother's factory, was an extensive armory engaged in supplying guns to the government. The proprietor had introduced improvements by which with a simple lathe he could turn the barrel round, and of uniform thickness, but to turn the octagon form of the butt baffled all his efforts and those of every gun-maker in the country. The butt had to be reduced by hand-filing at a cost of $1 per gun. After a year of experimenting, the proprietor of the works heard of the rustic genius who had invented the tack machine, and, sending for him, he told him what was wanted. Thomas looked at the machine, and began a low monotonous whistle—a habit of his when in deep study—and after a little time suggested a simple, but altogether original cam movement. This being applied, removed the difficulty at once, and turning to the young man the delighted proprietor said, "Well, Thomas, I don't know what you won't do next. I would not be surprised if you turned a gun-stock." He had mentioned a thing that was neither round nor straight in any part of it, and to turn which was deemed an impossibility by mechanics. Thomas uttered another of his peculiar whistles, and stammered, "W-e-e will t-r-r try that." He was two years in "t-r-r trying" it, but by that time he had produced a machine which was one of the greatest improvements of the century, for its application in the industrial world to the turning of irregular shapes was most far-reaching. It revolutionized the business of gun-making. The news traveled over the country, being received at first with incredulity, but when the fact was beyond question amazement was boundless, and orders began to pour in, and the young man's fame and fortune were assured. For eight or ten of these machines ordered by the British government he received $40,000.

He was soon requested by the United States government to take charge of the stocking of the guns at the Springfield armory, and at once proceeded to invent a machine for mortising into the stock every part of the gun—a thing deemed impossible by mechanics. The difficult part was the cutter. He invented a tool that would cut on a straight line, bore a round hole, and cut down and round in any direction, so that when the mortise was completed the lock fitted closely to the stock. In the development of this machine all of his experiments were failures until he observed the cut of the borer-worm in an oak log. Splitting open the log he studied the creature's operations with a microscope and thus got his design—nature's own mechanical contrivance. We will mention only a few of Mr. Blanchard's inventions. His patents alone number twenty-five, and many of his inventions he did not patent. Before locomotives were thought of he invented a steam wagon. He also constructed a machine for bending large timber; an improved steamboat for ascending rapids; a machine for simultaneously cutting and folding envelopes; and various improvements in railroad machinery. In short, he was a mechanical prodigy. In early years all his powers seemed to center upon construction, but as he grew older his other faculties were developed, and his speech impediment was conquered, so that he came to be recognized as a man of more than ordinary intelligence and culture. He died in Boston, Mass., April 16th, 1864.

* From the Municipal and Railway Record.

CREASE HERE.

REVOL. PER MIN.	DIAMETER ¼″	⅜″	½″	⅝″	¾″	1″	1¼″	1½″	1¾″	2″	2¼″	2½″	2¾″	3″	3¼″
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—	10.79	11.79	12.76
20	—	—	—	—	—	—	—	—	—	10.47	11.78	13.08	14.39	15.71	17.02
25	—	—	—	—	—	—	—	—	11.45	13.09	14.72	16.36	17.99	19.63	21.27
30	—	—	—	—	—	—	—	11.78	13.74	15.70	17.67	19.63	21.59	23.56	25.52
35	—	—	—	—	—	—	11.45	13.74	16.03	18.32	20.61	22.90	25.19	27.49	29.77
40	—	—	—	—	—	10.47	13.08	15.72	18.32	20.94	23.56	26.17	28.79	31.42	34.03
45	—	—	—	—	—	11.78	14.72	17.69	20.61	23.56	26.52	29.44	32.39	35.34	38.28
50	—	—	—	—	—	13.09	16.36	19.65	22.90	26.18	29.53	32.72	35.99	39.27	42.54
55	—	—	—	—	10.79	14.39	17.99	21.61	25.19	28.79	32.49	35.99	39.59	43.20	46.79
60	—	—	—	—	11.77	15.70	19.63	23.58	27.48	31.41	35.44	39.26	43.19	47.12	51.05
65	—	—	—	10.63	12.75	17.01	21:26	25.54	29.77	34.03	38.38	42.53	46.79	51.05	55.30
70	—	—	—	11.45	13.74	18.32	22 90	27.52	32.07	36.65	41.33	45.80	50.39	54.98	59.56
75	—	—	—	12.27	14.72	19.63	24.54	29.49	34.36	39.27	44.27	49.08	53.99	58.90	63.81
80	—	—	10.47	13.08	15.70	20.94	26.17	31.45	36.65	41.88	47.22	52.35	57.59	62.83	68.07
85	—	—	11.12	13.90	16.68	22.25	27.81	33.41	38.94	44.50	50.16	55.62	61.19	66.76	72.32
90	—	—	11.78	14.72	17.66	23.56	29.44	35.38	41.23	47.12	53.11	58.89	64.79	70.68	76.57
95	—	—	12.43	15.64	18.64	24.87	31.28	37.34	43.52	49.74	56.05	62.16	68.39	74.61	82.83
100	—	—	13.09	16.46	19.62	26.18	32.92	39.33	45.81	52.36	59.00	65.46	71.99	78.54	
110	—	10.79	14.39	18.09	21.59	28.79	36.19	43.25	50.39	57.59	64.89	72.00	79.19	86.39	
120	—	11.77	15.73	19.73	23.55	31.46	39.46	47.18	54.97	62.83	70.78	78.55			
130	—	12.75	17.01	21.35	25.51	34.03	42.71	51.11	59.55	68.06	76.67	85.09			
140	—	13.73	18.37	22.98	27.47	36.65	45.96	55.03	64.14	73.30	82.56				
150	—	14.72	19.63	24.61	29.44	39.27	49.22	58.96	68.72	78.54					
160	10.47	15.70	20.94	26.23	31.40	41.88	52.47	62.89	73.30	83.77					
170	11.12	16.68	22.25	27.86	33.36	44.50	55.72	66.81	77.88						
180	11.78	17.66	23.56	29.48	35.32	47.12	58.97	70.74	82.46						
190	12.43	18.64	24.87	31.11	37.29	49.74	62.22	74.67							
200	13.09	19.62	26.18	32.74	39.25	52.36	65.45	78.64							
210	13.79	20.60	27.48	34.36	41.21	54.97	68.72	82.52							
220	14.39	21.59	28.79	35.94	43.18	57.59	71.99								
230	15.05	22.57	30.10	37.61	45.15	60.21	75.26								
240	15.70	23.55	31.41	39.74	47.11	62.83	78.53								
250	16.36	24.53	32.72	40.87	49.07	65.45	81.81								
260	17.06	25.50	34.13	42.50	51.01	68.26									
270	17.72	26.49	35.44	44.14	52.98	70.88									
280	18.37	27.47	36.75	45.77	54.94	73.50									
290	19.03	28.45	38.06	47.41	56.90	76.12									
300	19.68	29.43	39.37	49.04	58.86	78.74									
310	20.33	30.41	40.67	50.68	60.83	81.35									
320	20.99	31.39	41.98	52.31	62.79										
330	21.64	32.37	43.29	53.95	64.75										
340	22.30	33.36	44.60	55.58	66.72										
350	22.95	34.34	45.90	57.22	68.68										
375	24.59	36.82	49.18	65.40	73.64										
400	26.22	39.25	52.45	73.57	78.50										
450	29.49	44.20	58.99												
500	32.76	49.16	65.53												

REVOL. PER MIN.	DIAMETER 3½″	3¾″	4″	4½″	5″	5½″	6″	6½″	7″	7½″	8″	9″	10″	11″	12″
5	—	—	—	—	—	—	—	—	—	—	10.47	11.95	13.09	14.40	15.71
8	—	—	—	—	10.47	11.52	12.56	13.61	14.66	15.71	16.75	20.51	20.94	23.04	25.05
10	—	—	10.95	11.79	13.09	14.99	15.71	17.02	18.32	19.63	20.94	23.89	26.18	28.80	31.41
15	13.75	14.73	16.43	17.68	19.63	21.60	23.56	25.52	27.49	29.45	31.43	35.84	39.27	43.19	47.12
20	18.33	19.64	21.91	23.58	26.18	28.80	31.42	34.03	36.65	39.26	41.91	47.79	52.36	57.59	62.83
25	22.92	24.55	27.39	29.47	32.72	36.00	39.27	42.54	45.81	49.08	52.38	59.74	65.45	71.99	78.54
30	27.50	29.46	32.87	34.37	39.27	43.20	47.12	51.05	54.97	58.90	62.85	71.68	79.54		
35	32.08	34.36	38.34	41.26	45.81	50.40	55.00	59.55	64.14	68.72	73.32	83.63			
40	36.66	39.27	43.82	47.16	52.36	57.60	62.83	68.06	73.30	78.53	83.79				
45	41.25	44.18	49.30	53.05	58.90	64.80	70.68	76.57	82.46						
50	45.83	49.09	54.78	58.95	65.45	72.00	78.54								
55	50.42	55.00	60.26	64.84	71.99	79.20									
60	55.00	59.91	65.73	70.73	78.55										
65	59.58	64.82	71.21	76.63											
70	64.16	68.72	76.69	82.52											
75	68.75	73.64	82.16												
80	73.33	78.64													
85	77.91														
90	81.50														

SURFACE SPEEDS IN FEET
PER MINUTE

MACHINERY, NEW YORK.

PUNCH O

PUNCH O

CREASE HERE.

LATHE WORK.

Maximum Feeds, Turning, Revolutions per inch of Travel, Single Cutter.

Dia.	Tool Steel. Rough	Finish.	Wrought Iron. Rough	Finish	Cast Iron. Rough	Finish
⅜	60	60	40	60		
½	60	60	30	60		
⅝	50	60	30	60		
¾	40	60	30	60		
⅞	30	60	30	60		
1	30	60	30	60	30	40
1¼	25	50	30	60	25	30
1½	25	50	30	60	25	25
2	25	50	25	60	25	25
2½	25	50	25	50	20	25
3	25	40	25	50	20	20
3½	25	40	25	50	18	16
4	25	40	20	50	18	16
4½	25	40	20	50	16	16
5	25	40	20	50	16	14
5½	25	40	20	50	14	14
6	25	40	20	50	14	12

The above is for ordinary cuts, small reduction.

Turning, 1 to 2 inches Diameter, Machinery Steel.

Feet per Minute.
Cuts one-half of diameter (medium feed)...20 to 25
Cuts one-fourth of diameter ....25 to 30
Cuts one-sixth of diameter .... 30 to 35
Cuts one-eighth of diameter .... 40 to 45
Light cuts, soft stock .... 50 to 60

*The above is working on given area plan. Speeds as noted are good practice, confirmed by a large number of careful observations. If above seem fast it is probably owing to one of the following reasons: The lard oil used is not genuine, material worked extra tough, steel in cutting tools of poor quality, or all three. Do not decide on speed without thought of feed, for on rough work the latter should always be as coarse as is possible to make it, even if it reduces the running speed. For accurate work, fine feeds and high speeds are better.

SCREW MACHINE PRACTICE.

Turning Speeds, Medium Chips.

Dia.	Cast Iron RPM.	FPM.	Brass. RPM.	FPM.	Mch. Steel. RPM.	FPM.	Tool Steel. RPM.	FPM.
½	382	50	1146	150	329	43	190	25
¾	250	49	713	140	213	42	117	23
1	183	48	497	130	156	41	84	22
1¼	143	47	367	120	122	40	64	21
1½	117	46	280	110	99	39	53	21
1¾	98	45	229	105	83	38	43	20
2	84	44	191	100	70	37	38	20
2½	67	44	144	95	53	35	29	19
3	56	44	115	90	43	34	23	18
3½	47	43	93	85	39	32	19	17
4	40	42	81	85	29	30	16	17
4½	35	41		84	25		14	16

For cutting threads use 50 to 60% of above (ordinary v. threads).

On special alloys the speeds would be changed somewhat.

Cored malleable iron castings are run same as cast iron.

Screw Cutting, 7-8 in. to 2 in. Diameter. Machinery Steel.
(Jones & Lamson).

Feet per Minute.
Long threads, 6 to 12 per inch.................. 10
Soft steel or iron, 6 to 12 per inch............... 15
Fine threads, above 14 per inch, Vths 20

* * *

MILLING CUTTER SPEEDS.

Milling cutters, on light cuts, should run at about the same speed as same diameter of stock in turning speed table of the given material, though on cast iron* with scale it sometimes becomes necessary to drop down considerably.

The following results have been the highest that could be ob-

—Contributed by "C. L. G."

MACHINERY, NEW YORK

PUNCH C

PUNCH C

These data sheets are issued quarterly, and are intended to be cut into f sections, 6 x 9 inches in size, as indicated by the straight lines. They may t be bound into note book form for convenient reference by means of staples serted in holes punched at the points indicated.

PUNCH O

CREASE HERE.

PUNCH O

REV. PER MIN.	DIAMETER 1′										2′				
	12	13	14	15	16	17	18	19	20	22	24	26	28	30	32
.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
.9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.2	—	—	—	—	—	—	—	—	—	—	—	—	—	9.42	10.05
1.4	—	—	—	—	—	—	—	—	—	—	—	—	10.26	11.00	11.72
1.6	—	—	—	—	—	—	—	—	—	—	10.08	10.89	11.72	12.56	13.40
1.8	—	—	—	—	—	—	—	—	—	10.37	11.31	12.25	13.19	14.13	15.07
2.	—	—	—	—	—	—	—	9.95	10.47	11.52	12.56	13.61	14.66	15.71	16.75
2.25	—	—	—	—	—	10.01	10.60	11.18	11.78	12.96	14.14	15.31	16.49	17.67	18.84
2.5	—	—	—	9.81	10.47	11.12	11.78	12.42	13.09	14.40	15.76	17.02	18.33	19.63	20.94
2.75	—	—	10.08	10.80	11.51	12.23	12.95	13.66	14.40	15.84	17.28	18.72	20.16	21.60	23.03
3	—	10.21	10.99	11.78	12.56	13.35	14.13	14.89	15.71	17.28	18.85	20.42	21.99	23.56	25.42
3.5	10.50	11.91	12.83	13.74	14.66	15.57	16.49	17.36	18.33	20.16	21.99	23.85	25.66	27.49	29.31
4.	12.57	13.61	14.16	15.70	16.75	17.80	18.85	19.84	20.94	23.04	25.14	27.26	29.32	31.41	33.50
4.5	14.14	15.31	16.49	17.67	18.84	20.02	21.20	22.31	23.56	25.92	28.28	30.66	32.98	35.34	37.69
5.	15.71	17.02	18.33	19.63	20.94	22.25	23.56	24.78	26.18	28.79	31.42	34.06	36.65	39 27	41.88
5.5	17.28	18.72	20.16	21.60	23.03	24.47	25.91	27.25	28.80	31.67	34.56	37.47	40.32	43.20	46.66
6.	18.85	20.42	21.99	23.56	25.13	26.70	28.27	29.72	31.42	34.55	37.70	40.87	43.98	47.12	50.25
6.5	20.42	22.12	23.82	25.52	27.22	28.92	30.63	32.20	34.63	37.43	40.84	44.27	47.65	51.05	54.44
7.	21.94	23.82	25.66	27.49	29.31	31.15	32.98	34.67	36.65	40.31	43.99	47.68	51.31	54.98	58.63
7.5	23.56	25.53	27.49	29.45	31.41	33.37	35.34	37.14	39.27	43.19	47.13	51.08	54.98	58.90	62.82
8.	25.13	27.23	29.32	31.41	33.50	35.60	37.69	39.61	41.89	46.07	50.27	54.48	58.64	62.83	67.01
8.5	26.70	28.93	31.15	33.38	35.60	37.82	40.05	42.08	44.51	48.94	53.41	57.89	62.31	66.76	71.19
9.	28.28	30.63	32.99	35.34	37.69	40.05	42.41	44.56	47.12	51.82	56.55	61.29	65.97	70.68	75.38
9.5	29.85	32.33	34.82	37.30	39.78	42.27	44.76	47.03	49.74	54.70	59.69	64.69	69.64	74.61	79.57
10	31.42	34.03	36.65	39.26	41.88	44.51	47.13	49.50	52.36	57.58	62.84	68.10	73.30	78.54	
11	34.56	37.44	40.32	43.19	46.07	48.97	51.85	54.48	57.60	63.34	69.12	74.91	80.63		
12	37.70	40.84	43.98	47.12	50.26	53.43	56.57	59.45	62.83	69.10	75.40	81.71			
13	40.84	44.24	47.65	51.04	54.44	57.89	61.29	64.42	68.07	74.86	81.68				
14	43.98	47.65	51.31	54.97	58.63	62.35	66.01	69.40	73.30	80.62					
15	47.03	51.05	54.98	58.90	62.82	66.81	70.73	74.37	78.54						
16	50.17	54.45	58.64	62.82	67.01	71.27	75.45	79.35	83.78						
17	53.31	57.86	62.31	66.75	71.20	75.73	80.17	84.32							
18	56.45	61.26	65.97	70.68	75.39	80.19									
19	59.59	64.85	69.64	74.60	79.58										
20	62.73	68.27	73.30	78.53											

REV. PER MIN.	DIAMETER 3′			4′			5′			6′		7′		8′	1
	36	40	44	48	52	56	60	64	68	72	78	84	90	96	1:
.5	—	—	—	—	—	—	—	—	—	—	10.21	10.99	11.78	12.56	15
.6	—	—	—	—	—	—	—	10.05	10.68	11.31	12.25	13.19	14.14	15.08	18
.7	—	—	—	—	—	10.26	10.99	11.72	12.46	13.19	14.29	15.39	16.49	17.59	21
.8	—	—	—	10.10	10.89	11.73	12.56	13.40	14.24	15.08	16.34	17.59	18.85	20.11	25
.9	—	—	10.37	11.31	12.25	13.19	14.13	15.07	16.02	16.96	18.38	19.79	21.20	22.62	28
1.	—	10.47	11.52	12.56	13.61	14.66	15.70	16.75	17.80	18.85	20.42	21.99	23.56	25.13	31
1.2	11.31	12.57	13.82	15.08	16.25	17.59	18.84	20.10	21.36	22.62	24.50	26.39	28.26	30.16	37
1.4	13.19	14.66	16.13	17.54	18.97	20.52	21.99	23.45	24.92	26.39	28.59	30.79	33.00	35.18	43
1.6	15.08	16.76	18.42	20.15	21.69	23.46	25.13	26.80	28.48	30.16	32.67	35.18	37.68	40.21	50
1.8	16.96	18.85	20.73	22.62	24.41	26.39	28.27	30.15	32.04	33.93	36.76	39.58	42.39	45.24	56
2.	18.85	20.94	23.04	25.13	27.14	29.32	31.41	33.50	35.60	37.70	40.84	43.98	47.13	50.26	62
2.25	21.20	23.56	25.92	28.27	30.54	32.99	35.34	37.69	40.05	42.41	45.94	49.78	53.01	56.55	70
2.5	23.56	26.18	28.79	31.41	33.94	36.65	39.27	41.88	44.51	47.12	51.05	54.98	58.89	62.83	78
2.75	25.92	28.80	31.67	34.56	37.35	40.32	43.29	46.06	48.96	51.83	56.15	60.47	64.80	69.11	86
3.	28.27	31.42	34.55	37.70	40.75	43.98	47.12	50.25	53.41	56.55	61.26	65.97	70.68	75.39	
3.5	32.98	36.65	40.31	43.99	46.96	51.31	54.98	58.63	62.31	65.97	71.47	76.97	82.47	87.98	
4.	37.70	41.89	46.07	50.27	53.76	58.64	62.83	67.00	71.21	75.40	81.68	87.96			
4.5	42.41	47.12	51.83	56.56	60.57	65.97	70.68	75.38	80.11	84.82					
5.	47.12	52.36	57.59	62.84	67.38	73.30	78.54	83.76							
5.5	51.83	55.60	63.35	69.12	74.18	80.63	86.39								
6.	56.54	62.83	69.11	75.41	80.99										
6.5	61.26	68.07	74.87	81.69											
7.	65.97	73.30	80.63												
7.5	70.68	78.54													
8.	75.39	83.78													
8.5	80.11														

SURFACE SPEEDS IN FEET

PER MINUTE

Calculated by C. C. Stutz and first published in May, 1899, MACHINERY.

PUNCH O

CREASE HERE.

PUNCH O

MILLING SPEEDS (Continued).

tained in ordinary shop routine, giving due consideration to economy and the time taken to change and grind cutters when dull:

Stock.	Periphery Speed.	Depth Cut.	Feed per Min.
Wrought Iron	36 to 45 ft. P. M.	1	⅝
Soft Mild Steel........	30 to 38	¼	¾
Gun Metal	80	½	¾
Cast Iron*	26 to 35	½ to 2½	¾ to 5/16
Steel Bars H..........	21 to 26	1/32	¾

The Newton Milling Machine Co., internally lubricated cutters, have cut nine inches length, one minute (Milling Machine Platen), depth of cut ⅜″ periphery, speed 50 ft. per minute, width about 4″ (Mchy. '96). Therefore 50 ft. equals 600″ circumference, and assuming that there were 900 teeth in same distance, i. e., 2/3″ apart, it would give each tooth .01 chip.

DRILLING SPEEDS.

Speeds for turning are suitable for drilling, although they may in some cases be exceeded.

For small drills, after thorough trials, high speeds and fine feeds as follows are recommended (feeds .002 to .005).

Dia.	Steel. R. P. M.	Cast Iron. R. P. M.
1/16	4200	5500
⅛	2000	2500
3/16	1200	1550
¼	900	1100
5/16	650	825
⅜	500	625
7/16	400	500
½	330	400

While the diameter of a small drill varies directly from that of a larger one, its area does not; hence the small drills may be run at much higher periphery speeds. A proper method of figuring drilling speeds would seem to base same on area covered in given time.

SPIRAL TWO-LIP DRILLS.

Dia. of Drill.	Rev. per Min.	Max. feed per Min.
½	330	2.50
¾	215	2.15
1	160	1.75
1⅛	147	1.60
1¼	125	1.38
1½	100	1.10
1¾	85	1.02
2	70	.98

Machinery steel.

DRILLING.

Prentice recommends on drills under ⅜″ fine feeds of .002 .003 per revolution, and high speeds.

Maximum screw machine practice for holes having depth n exceeding 2 or 3 diameters.

Dia.	Feed.	
¼	.007 per revolution in steel.	
½	.008 " " " "	
¾	.01 " " " "	
1	.0105 " " " "	holes may be 3½ to 4″ deep, with oil drills.
1¼	.0105 " " " "	
1½	.011 " " " "	
1¾	.012 " " " "	
2	.014 " " " "	

LUBRICANTS FOR CUTTING TOOLS.

(From Morse Twist Drill Catalogue.)

Material.	Turning.	Chucking.	Drilling.	Reaming.	Tappi Milli
Tool Steel	Dry or Oil	Oil or Soda Water	Oil	Lard Oil	(
Soft Steel	Dry or Soda Water	Soda Water	Oil or Soda Water	Lard Oil	(
Wrought Iron	Dry or Soda Water	Soda Water	Oil or Soda Water	Lard Oil	(
Cast Iron	Dry	Dry	Dry	Dry	D
Brass	Dry	Dry	Dry	Dry	D
Copper	Dry	Dry	Dry	Mixture	D
Babbitt	Dry	Dry	Dry	Dry	D
Glass	Turpentine or Kerosene				

Mixture is ¼ Crude Petroleum, ¾ Lard Oil. Oil is Sperm or Lard, Sperm pre able. When two lubricants are mentioned the first is preferable.

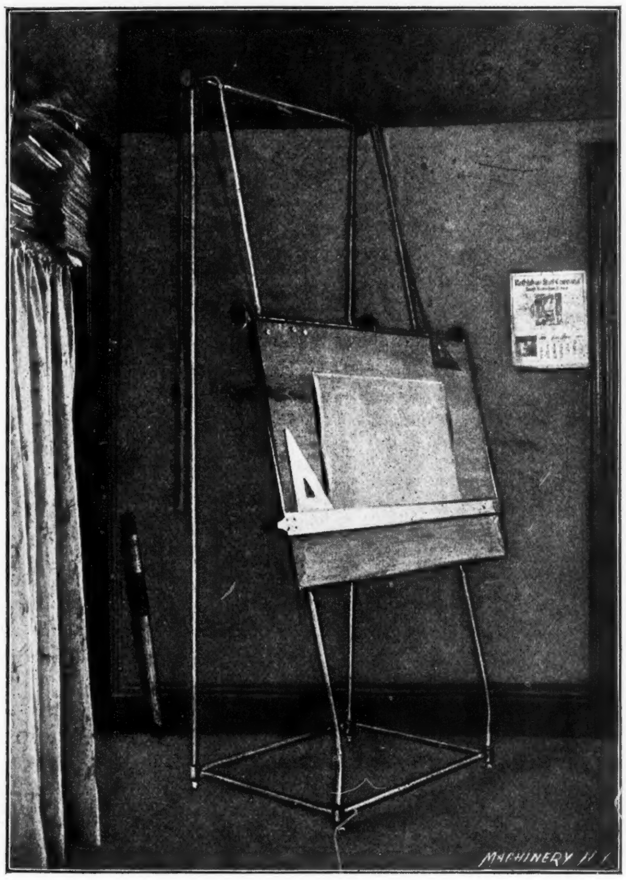
—Contributed by "C. L. G."

LETTERS UPON PRACTICAL SUBJECTS.

A CONVENIENT DRAFTING BOARD.

Editor MACHINERY:

Some one has said: "If we deduct from the sum total of our mechanical knowledge what has been contributed by the workmen in the shop, the remainder would be small indeed." It is not our purpose at this time to discuss the truth or falsity of this statement, but certain it is, however, that a large proportion of the good things in our mechanical work have emanated from 'him of the overalls and jumper," and we fear in many cases the credit for the same has, somehow, got side-tracked before it reached its proper destination. While human nature remains as it is, we cannot hope for radical improvement in this particular. In view of the excellent results obtained by the firms who have adopted the plan of offering prizes for suggestions coming from the workmen, it is surprising that more of our wideawake managers do not realize that "it pays."



Adjustable Drafting Board and Parallel Ruler.

With the too prevalent cry of: "A fair day's work for a fair day's pay" on the one hand, and the seeming reluctance to give the common workman due credit for his good suggestions on the other, it is a wonder that we have received any assistance whatever from that source. In view of this prevalent attitude on the part of the labor agitators and the managers, great credit is certainly due the man who, after ten hours' work in the shop, will spend three or four more over a drafting board on the kitchen table, by the light of a kerosene lamp, in the attempt to solve some mechanical problem relating to the improvement of his employers' machine or methods of manufacture, with even chances that the credit for the same will be appropriated by some one between himself and the management. It is for the benefit of such as these, the life and soul of our mechanical supremacy, that we wish to call attention to a cheap and convenient drafting board and stand that has helped the writer to solve many knotty problems in the past and no doubt will continue to do so for some time to come.

Referring to the illustration, it will be seen that the frame is made up of ½" gas pipe. At the upper and lower corners are railing tees with side openings; on the four lower corners the bottom openings have ½" plugs which are drilled for common castors to facilitate moving about; in the outer ends of the two upper tees are also inserted ½" plugs and these are drilled and tapped for ⅜" cap screws upon which revolve the sheaves for the counter weights for the board. These sheaves are about 2½" in diameter and grooved for ordinary sash cord and the weights are simply cast-iron sash weights sufficient to balance the board. The base of this frame is 24" by 30" and the height from center to center of cross bars is 8' 0", this being ample to permit raising the board to proper height to work near its lower edge when standing up. The board is 31" x 41" and has attached to its back near the top three brackets, through which passes the ½" cold-rolled shaft for the straight edge. On either end of this shaft are sheaves about 3" in diameter at the bottom of the groove. The groove is of sufficient width and depth to wind 30" of ordinary wire-wove tape. One end of each tape is attached to the straight edge, the other to the sheaves. Attachment to the sheaves is made by drilling a 3-16" hole, about a ¼" inside of the bottom of the groove, then cutting through the flanges of the sheave to this hole with a hack-saw. Into these slots is inserted the end of tape, which is securely held in place by a pin driven into the hole.

It will be seen that if the sheaves are of the same diameter at the bottom of the groove and the tapes are of the same thickness the winding or unwinding tapes will maintain constantly parallel positions of the straight edge. On the same shaft near the center of the board are a similar sheave and tape to the end of which is attached a weight just sufficient to balance the straight edge and attachments. The straight edge may be of any close-grained wood, but that used in the present instance is a 42" celluloid edge manufactured by Keuffel & Esser, of New York. The straight edge being one inch longer than the board permits attachment of a ½" square cleat at each end on the back to prevent lateral motion, while the spring attached to the front near the ends and curving round behind the board, ending in two lugs with a roller between, which revolves against back of board, serves to hold it in close contact with the board and at the same time permits insertion of any ordinary thickness of paper.

The only improvement which experience has suggested in this arrangement would be the addition of a small trough on the front of straight edge, near its lower side, to serve as a receptacle for tools and at the same time to prevent bulging out in center due to pressure of springs, which occurs when very thick paper is used or when the straight edge is located over the head of a thumb tack near the end of the board.

To one who, like the writer, has worked upon both the flat and upright board, the question strongly asserts itself: Why has the flat board not been banished to the scrap pile along with the chain-feed lathe and the flat drill? Both the draftsman and the manager have a vital interest in the matter; the former from a physiological standpoint, as the upright board permits him to stand erect, saving his eyes and his back and permitting him to reach all parts of his drawing board without being a contortionist; the latter from a purely commercial standpoint, as the energy transformed into eye strain and backache on the flat board is productive of straight lines and circles on the upright board and experience has demonstrated that at least 25% more work can be produced in a given time on this type. The only difficulty encountered in working on an upright board is in the use of the crow quill pen for lettering, but the writer abandoned this long ago for the writing stick, which is simply a piece of ¼" oak dowel-pin from the pattern shop, carefully pointed on the emery cloth pencil sharpener, and which, with a little experience, gives much more even work than the pen.

It might be said in closing that there is no patent on this stand and board and that any one is at liberty to use it or any modification thereof that his fancy may suggest.

Buffalo, N. Y. S. I. BLEY.

* * *

HOW A PATTERN WAS CHANGED SO THAT SEVERAL FORMS OF CASTINGS COULD BE MADE FROM IT.

Editor MACHINERY:

The following may prove of interest to some of the younger readers of MACHINERY:

It was found necessary to change the relation of two eccentrics

(in the form of a hub) on a piece of a machine to suit different requirements. The original relation was to be retained. There were only a few of these special pieces wanted at a time, and it was decided to try and change the regular pattern so as to have removable pieces to suit the different conditions. One of these removable pieces was to be the original hub.

There were four patterns made of brass, in halves, and fastened to match-plates. The hub half is shown by Fig. 2, with the exception that instead of a screw in the center there was a 5/16" pin that went into the pattern about 3/8", and the hub and body were one piece.

The problem that now presented itself was how to remove the hub C and get it back again in the same position, without changing the relations. The hub was to be cut off below the second eccentric, or at B. The present relation of eccentrics had been obtained by considerable experimenting, and we did not wish to have a new hub made if we could keep the present one and not change the relations. In Fig. 2 you will see that there was not sufficient room between the rim and hub for a tool to cut off the hub at B. That was what puzzled us most. The method pursued was as follows: We removed the 5/16" center pin and drilled the hole through the hub. Then we removed the pattern from the match-plate and bored out the 5/16" hole to 3/8", true with the seat. The hole for pin D was drilled into the second eccentric beyond the cutting-off point B; then the hole for the bushing F was bored large enough to receive a cutting-off tool that would reach through the thickest part of the hub and deep enough beyond the cutting-off point B to form a guide for the hub when the bushing F was in place. The pattern was now ready to have the hub cut off. This was done with the inside cutting-off tool. Then the faces were trued and a brass washer, just the thickness of the stock removed in cutting off, was soldered to the pattern A, as shown at B, and the pin hole drilled through it. The hub was counterbored for the head of screw E, and the bushing F and pin D were then made. Screw E was a stock screw with diameter of head reduced. The 5/16" hole in the match plate was tapped to fit the screw E.

We could now fasten the hub C to the body A, and leave it in exactly the same position as it was before the change was made. The slot in the screw was filled with soft solder.

New hubs were now made, giving the relation of eccentrics as desired, two of which are shown by Figs. 1 and 3. These were fastened to the pattern in the same way as described for the regular hub. EDWIN C. THURSTON.

Providence, R. I.

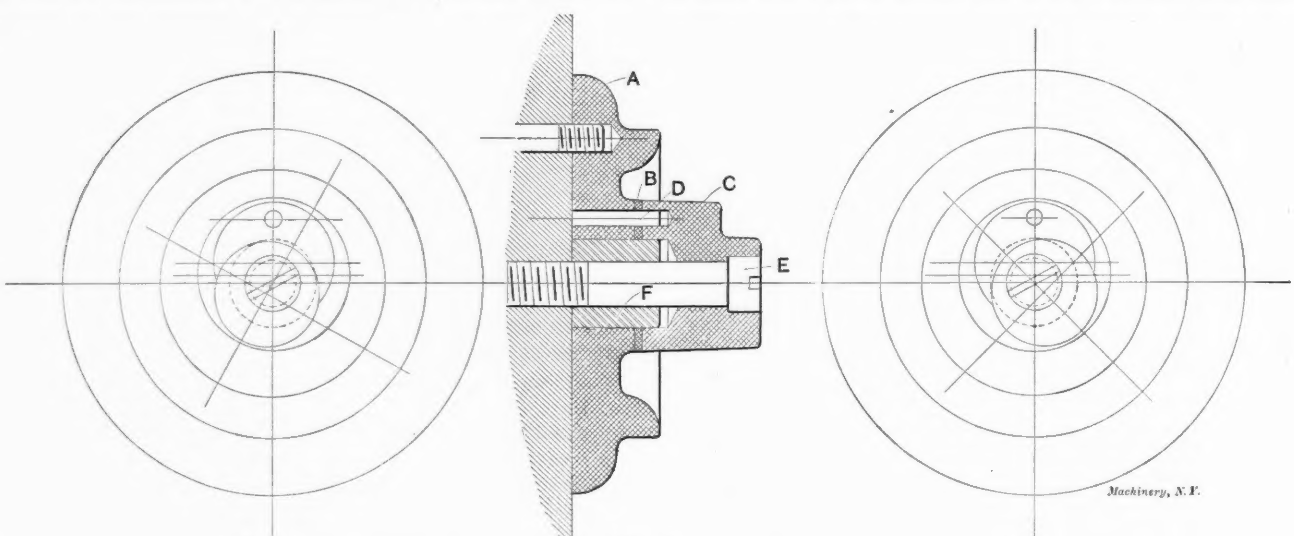


Fig. 1. Fig. 2. Fig. 3.

* * *

WORM THREAD TERMS—MODULE.

Editor MACHINERY:

Mistakes were made, at different times, in threading worms, because the drawings were not understood. The mistakes became frequent and expensive. About twelve years ago, the drafting department of the Brown & Sharpe Mfg. Co. decided that the drawings had not been marked clearly, and a system of marking was devised which has avoided misunderstandings.

Questions No. 63 in the July number of MACHINERY, and No. 57 in the May number, show that there is still an interest as to the correct terms to use in connection with screws and worms. Perhaps the terms as adopted by the Brown & Sharpe Mfg. Co. will be found convenient to others. These terms are the same as have been in common use, but every term is limited to exactly one meaning and is never used to mean anything else. They are as follows:

1.—Lead. 2.—Turns to an inch. 3.—Single threaded, double threaded, etc., right- or left-handed. 4.—Pitch. 5.—Threads to an inch.

1. Lead is always used to denote the distance that the screw or worm thread advances in one turn, which is the same as given in MACHINERY for May.

2. "Turns to an inch" denote the number of times a screw must turn in order to advance one inch.

"Lead" and "turns to an inch" are reciprocals of each other; that is, divide 1 inch by the lead and the quotient will be the turns to an inch; divide 1 inch by the turns to an inch, and the quotient will be the lead. Either the lead or the turns to an inch is wanted in order to figure the change gears to use in threading. For a milling machine, the gears are usually figured from the lead, while for a lathe the gears are figured from the turns to an inch.

3. "Single-threaded" means threaded once, or that the screw is threaded with a single-pointed tool at one operation, thus cutting one groove only. "Double-threaded" means threaded twice, which can be done either with a double-pointed tool at one operation, or with a single-pointed tool in two operations, thus cutting two grooves. "Triple-threaded" means threaded three times, or that the screw has three thread grooves. This term can be extended to quadruple-threaded, five-threaded, six-threaded and so on to any number..

4.—Pitch—It was thought best to use the term pitch in the same sense as it is used in connection with gearing, because when a worm and a worm-wheel run together they should evidently be of the same pitch, according to the fundamental principles of gearing. In the sense adopted, the pitch of a worm always relates to the distance between the center of one thread and the center of the next thread, in accordance with the definition of pitch in MACHINERY for May, page 285. If we are working in circular or linear pitch, the distance between two consecutive threads is the circular or linear pitch.

Occasionally a worm is named as of a diametral pitch, which means that the worm is to run with a gear that is sized according to the diametral pitch named. A worm called 8 diametral pitch means a worm to run with a gear having 8 teeth to every inch in the diameter of the pitch circle. The distance between two consecutive threads, or the linear pitch of such a worm, is .393 inch, nearly.

If a worm is single-threaded, the linear pitch is equal to the lead of the worm; if multiple-threaded, the linear pitch is less than the lead. Divide the lead by the number of times a worm is threaded, and the quotient will be the linear pitch. For example, if a worm is 1½-inch lead and is threaded 3 times, or is

triple-threaded, the pitch will be 1½ inch divided by 3, which equals ½ inch.

5. "Threads to an inch" means the number of thread coils that can be counted in one inch, when a rule is held parallel against a screw. The linear pitch and the threads to an inch are reciprocals of each other; divide 1 inch by the linear pitch and the quotient is the number of threads to an inch; divide 1 inch by the number of threads to an inch and the quotient is the linear pitch.

A single-threaded screw may have any number of coils to an inch; in other words, a single-threaded screw may have any number of threads to an inch. On the other hand, a screw may have only one thread to an inch and yet be multiple-threaded. For example, a single-threaded screw can have 5 threads to 1 inch. In this example, the screw is 1-5th inch lead, 5 turns to 1 inch, and the linear pitch is 1-5th inch. Again, a five-threaded screw can have one thread to an inch. In this example, the lead is 5 inches, the screw makes 1-5 turn to an inch, and the linear pitch is 1 inch.

In connection with worms, there is, nowadays, not much need of the term, "threads to an inch." It is much used in connection with common screws, of which a large majority are single-threaded. In single-threaded screws, the number of turns to an inch is equal to the number of threads to an inch. In double-threaded screws the number of threads to an inch is twice the number of turns to an inch, and so on.

The safest way to mark a drawing relative to the threading of a worm is to designate the following parts:

1, the lead; 2, the turns to an inch; 3, whether single- or multiple-threaded, and whether right- or left-handed; 4, the linear or circular pitch.

Instead of writing the full term single-threaded or double-threaded, it is sufficient to write simply "single" or "double," and so on. For right-handed we can write R. H., and for left-handed, L. H. Instead of writing the full term linear pitch or circular pitch, we can simply write the letter P with an accent mark, thus, P'.

As an example of marking, a drawing for a worm ½" lead, double-threaded, left-handed would be marked:

½" lead, 2 turns to an inch, double, L. H., .250" P'.

If a drawing fails to state either in words or in abbreviations, which hand a thread is to be, it is never safe to thread a worm, even though the hand is clearly shown in the drawing. For his own protection, a machinist should have the hand clearly written down, and he should be guided by what is written rather than by what is drawn.

It is not expected that the foregoing limitations will be adopted in all the uses of the term "pitch." A man that makes screw propellers will, no doubt, continue to use it in his old way, and, perhaps, also, the man that makes ordinary single-threaded screws; but if a maker of multiple-threaded worms continues to use it in its old loose significations, there will be times when he will feel like shutting himself up long enough to go over a chapter in Book I on first principles.

Suppose that we have two gear blanks to be cut to run together and that one is enough larger than the other to contain one more tooth; what shall we call this difference in diameter?

The Brown & Sharpe Mfg. Co. have adopted the word module as a convenient term. It is used in France and in Germany, only the Germans spell it without an e. There are as many modules in the diameter of the pitch circle of a spur gear as there are teeth in the gear. Hence, divide the diameter of the pitch circle of a spur gear by the number of teeth and the quotient is the module.

We can figure the tooth parts of a gear from the module as easily as we can figure from the pitch. The meaning of this term cannot be easily mistaken.

Providence, R. I. JARNO.

* * *

A DRILL-PRESS BORING RIG FOR INTERCHANGEABLE WORK.

Editor MACHINERY:

The tools which I am about to describe were for boring and finishing the cast-iron shells shown at B, Fig. 1. The part finished is shown at F, being a seat for a brass ring that was to fit in snugly so as to be air-tight, and it was also necessary to have them all exactly the same size. I wish to say that we were making these shells in 500 lots.

The jig for holding the shells is shown in two views in Fig. 1, a top view and a cross section; A is the jig of cast-iron which was faced off on the bottom and strapped true on the face plate of the lathe by the ears E E. It was then bored out to the shape and size of the shells at C and a hole bored in the bottom for the plug D. It was then milled out at three places on the top to give the three wings B clearance. The plug D, made of machine steel, was then turned and finished so as to just fit the inside of the shells, as shown, and then driven into the jig A, projecting through at the bottom, as shown. The part projecting through just fitted the center hole in the table of the large drill-press in which the boring was done.

Fig. 2 shows the holder and tools for boring, which were made in the following manner: G is the holder proper made of cast-iron with three wings, to allow of using three cutting tools, as we found after experiment, that this number worked the best. The tool was first chucked and the hole I bored and reamed, for the shank J. It was then removed and the shank J turned and finished to fit the spindle of the drill press, with a shoulder at M. The other end was turned down so as to drive snugly into the holder G. The assembled tool was then put between centers

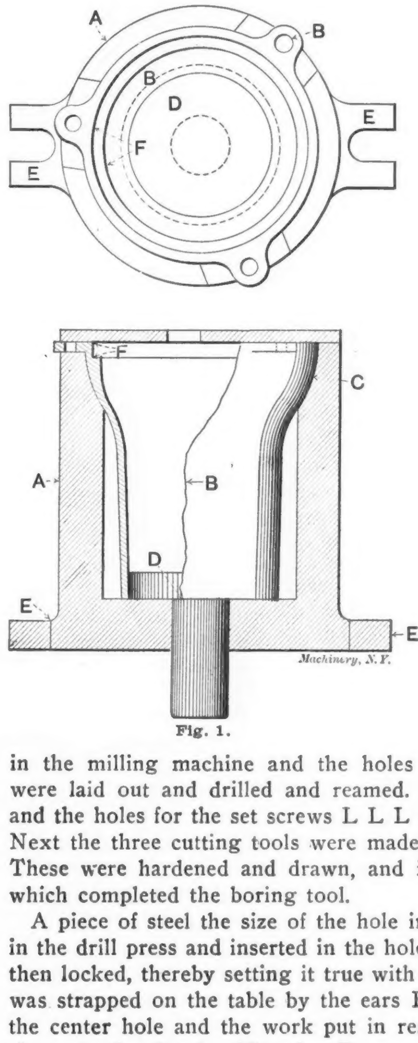


Fig. 1.

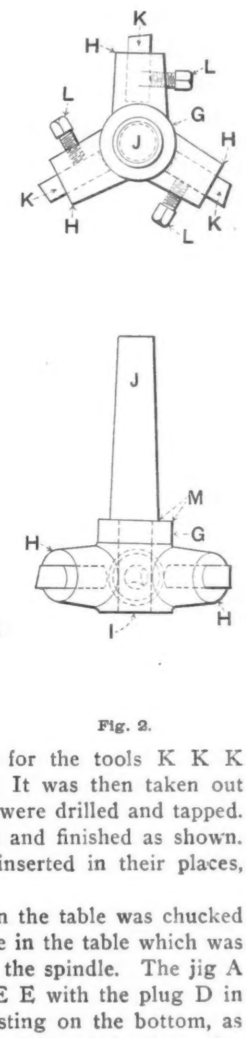


Fig. 2.

in the milling machine and the holes for the tools K K K were laid out and drilled and reamed. It was then taken out and the holes for the set screws L L L were drilled and tapped. Next the three cutting tools were made and finished as shown. These were hardened and drawn, and inserted in their places, which completed the boring tool.

A piece of steel the size of the hole in the table was chucked in the drill press and inserted in the hole in the table which was then locked, thereby setting it true with the spindle. The jig A was strapped on the table by the ears E E with the plug D in the center hole and the work put in resting on the bottom, as shown in the sketch. The plug D centered it and the three pins not shown entered the holes in the ears B, which prevented it from turning. The holder Fig. 2 was then set into the spindle and the tools set to cut exactly the right diameter and after being run down to the proper depth, the spindle stop was set.

The rest was plain sailing and, except for stopping to sharpen tools at long intervals the pieces were turned out very rapidly (each and every one alike) at a very small cost and much better and cheaper than they could have been done by any other practical means. The saving in the first 100 shells paid for the cost of the tools. JOSEPH V. WOODWORTH.

Brooklyn, N. Y.

* * *

THE CIRCUMFERENCE OF ELLIPSES.

Editor MACHINERY:

Since no less than two articles on this subject having recently

appeared in MACHINERY, you might as well do full justice to it by also publishing the following:

Let a and b be the semi-axes of an ellipse, and let $\frac{a-b}{a+b} = A$, then a correct formula for the circumference C is:

$$C = (a+b)\pi \left\{ 1 + \left(\frac{1}{2}\right)^2 A^2 + \left(\frac{1}{2.4}\right)^2 A^4 + \left(\frac{1.3}{2.4.6}\right)^2 A^6 + \left(\frac{1.3.5}{2.4.6.8}\right)^2 A^8 + - \right\}$$

$$= (a+b)\pi \left\{ 1 + \frac{1}{4} A^2 + \frac{1}{64} A^4 + \frac{1}{256} A^6 + \frac{25}{16384} A^8 + - \right\}$$

$$= (a+b)\pi S,$$

which is the one given in "Ingenieurs Taschenbuch," page 106 of the 1896 edition.

By a simple method, for which I am indebted to my former colleague, Prof. George Mc. C. Robson, of the International Correspondence Schools of Scranton, the fraction $\frac{64 - 3A^4}{64 - 16A^2}$ which is a remarkably close approximation to the value of the series S, is readily found.

In "Ingenieurs Taschenbuch," values of the series for various values of A are given. These have been verified and found correct to the four decimal places given, in all but one case. With this corrected, these values have been reproduced below, together with the values figured by the approximating fraction, which are given to six decimal places.

A	True Value of S.	Value of Fraction.
0.1	1.0025	1.002502
0.2	1.0100	1.010025
0.3	1.0226	1.022629
0.4	1.0404	1.040417
0.5	1.0635	1.063542
0.6	1.0922	1.092225
0.7	1.1268	1.126775
0.8	1.1677	1.167619
0.9	1.2155	1.215355
1.0	1.2732	1.270833

It will be seen that to four decimal places the agreement between the true values and the approximations is perfect up to $A = 0.7$, which corresponds to $\frac{b}{a} = \frac{3}{17}$; and as this represents an extreme degree of eccentricity, this approximation certainly leaves but little to be derived.

The following approximate formula for the circumference of an ellipse is accordingly an excellent one:

$$C = (a+b)\pi \frac{64 - 3A^4}{64 - 16A^2}$$

and as such does not require "the authority of a great name" to recommend it. The table below gives a comparison between older formulas and this one, the figures tabulated being the ratio of the circumference to the total major axis.

$\frac{b}{a}$	True Value.	Nystrom.	Molesworth.	Formula quoted by H. W. N. Cole.	Writer.
1	3.1416	3.1416	3.1416	3.1416	3.1416
⅔	2.6442	2.5707	2.6786	2.6444	2.6442
⅓	2.2275	2.1569	2.2180	2.2347	2.2275
0	2.0000	2.0000	2.0000	2.3562	1.9962

A further refinement of this formula is:

$$C = (a+b)\pi \frac{64 - 3A^4 + \left(\frac{192}{\pi} - 61\right)A^{20}}{64 - 16A^2}$$

in which form it also gives the correct value for $b = 0$.

Bethlehem, Pa. CARL G. BARTH.

* * *

CATCHING THE THREAD—POLYGONS.

Editor MACHINERY:

I would like to add a little to my letter on "Catching the Thread," which appeared in the June, 1899, issue of MACHINERY. I stated that if the lathe carriage be moved by hand to the same starting point as when the screw gear and face plate were marked, the nut can be thrown in when the marks come in the same position.

A shopmate asked me: "How often do these marks come in the same position?" My answer was: "That it depends upon the pitch of lead screw of lathe and the pitch of screw we are cutting." For example, if the lead screw of lathe has 3 threads per inch and the screw to be cut has 4 per inch, then they would come together after 4 revolutions of the spindle or 3 revolutions of the screw; so that if we missed throwing in the nut at the proper time, we could count the revolutions, and know just the instant to be ready to throw in the nut at the second trial. For another example—if the lead screw was 6 per inch and screw to be cut 8 per inch then the revolution would be 8-6 or 4-3 revolutions of the spindle and screw respectively.

Tables of Relative Dimensions of Polygons.

No. 1.—To be used when the inscribed diameter is known:

No. of Sides.	Inscribed Diam.	Circumscribed Diam.	Sides.
3	1	2.0000	1.73206
4	1	1.4142	1.0000
5	1	1.2361	.7268
6	1	1.1547	.5773
7	1	1.1099	.4815
8	1	1.0824	.4142
9	1	1.0642	.3639
10	1	1.0515	.3247

No. 2.—To be used when the circumscribed diameter is known:

No. of Sides.	Circumscribed Diam.	Inscribed Diam.	Sides.
3	1	.50000	.86603
4	1	.70701	.7071
5	1	.80903	.58779
6	1	.86603	.50000
7	1	.90101	.43389
8	1	.92387	.38268
9	1	.93969	.34200
10	1	.95102	.30900

No. 3.—To be used when the length of a side is known:

No. of Sides.	Side.	Inscribed Diam.	Circumscribed Diam.
3	1	.5780	1.1557
4	1	1.0000	1.4142
5	1	1.3750	1.7015
6	1	1.7320	2.0000
7	1	2.0790	2.3047
8	1	2.4150	2.6131
9	1	2.7470	2.9240
10	1	3.0770	3.2363

Occasionally in the shop I have found it convenient to use the appended table of polygons, to get the distance across corners, or flats, or the length of side. The table gives the dimensions for a unit of one, for any other value, multiply the dimension given in table. For example: What is the outside diameter and length of one side of an octagon, the distance across flats being 2 inches?

The circumference diameter from table (for 1 inch inscribed diameter) is 1.0824. $2 \times 1.0824 = 2.165$ inches.—Ans.

Length of side is from table .4142. $2 \times .4142 = .828$ inch.—Ans. JOHN T. GIDDINGS.

Providence, R. I.

* * *

A "COMPUTER" FOUND USEFUL FOR CALCULATING CHANGE GEARS.

Editor MACHINERY:

I never doted much on figures, but can usually manage to solve the problems that come my way, although I always feel as if some other fellow was laughing in his sleeve at my methods.

I have had a good many odd threads to cut on lathes of various makes. This is simple enough, but I cannot say that I ever enjoyed the "figuring out" of the proper combination of gears. I suspect that it is partly because the lathe builders make it so convenient for us that I have become lazy. Nice brass plates give all the different combinations supposed to be needed, and if you send for a special gear, a pretty blue print comes with it, giving all the different threads, fractional and otherwise, that its use makes possible. So when one of the workmen came in with a worried look and said that "that arbor on the machine that came with the scrap from the bankrupt C. X. Y. Co., had lost the nut and that he could not cut a 19 per inch thread," I did not even pick up a pencil. Too much work. I just took our pasteboard "Cox's Pulley and Gear Computer" and called the outside circle "number of teeth in gears" and the inside circle "pitch of screws." Then set 19 on inside circle (the required thread), against 40 on outside circle (the number of teeth in change gear), which in this case is permanently fastened to spindle, and against 10 on inside circle—the pitch of lead screw. I found 76 on outside circle, the number of teeth required in screw gear. The lathe had a 75 teeth gear which was near enough for a short nut. I also noted that the computer gave, at one setting, the required gear for any pitch lead screw, and that other combinations were

easily obtained. It is said that an unused muscle or faculty will become numbed and useless. Possibly we are too much given to spending our energies hunting up formulas, and if we do not find one, we give up or write to MACHINERY for an answer. However, I won't figure out any more odd threads if I can help it and can get at my "computer," not, at least, till cooler weather comes.

Tilton, N. H. CUE.

* * *

GAGE FOR TESTING THE CLEARANCE OF MILLING CUTTERS, ETC.

Editor MACHINERY:

The device shown in accompanying sketch I have found to be very useful for visibly testing the amount of clearance in milling cutters, reamers, etc.

There seems to be a good deal of misunderstanding as regards the proper amount of clearance a tooth should have. I have seen good mechanics test for clearance by placing a scale across two teeth, and if the points only touched it was claimed that the proper clearance had been obtained.

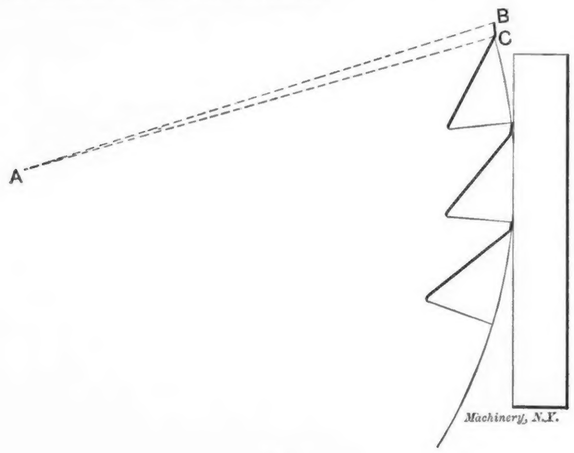


Fig. 1.

This is not only radically wrong, but it also perceptibly reduces the life and cutting qualities of the tool. It gives the tooth a very acute cutting edge with nothing to back it up and after using for a short time it becomes necessary to grind away from 10 to 15 thousandths in order to bring the tooth up to an edge. But if the distance A C (Fig. 1) is just a few thousandths less than A B the point will not wear as quickly and can be reground by taking off from 2 to 3 thousandths.

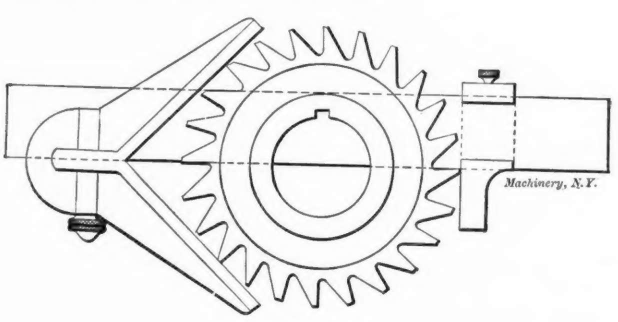


Fig. 2.

In using a large reamer for finishing a hole it is a distinct advantage to have the proper clearance so as to insure a smooth round hole and to prevent chattering. The tool itself I believe needs no description, it being simply a small sliding jaw squarely fastened to the blade of an ordinary center square, as shown by Fig. 2. H. J. BACHMANN.

New York City.

* * *

RIG FOR CAM CUTTING.

Editor MACHINERY:

Recently I had occasion to cut a cam, and as I had only an ordinary lathe with which to do the work, I was rather puzzled for a while. However, I soon found a way out of the difficulty.

A template was made from a piece of 3-32" steel, the exact size and form of the drawing and a 3/4" hole was drilled and reamed at the center of this, 3/4" being the size of the hole in the finished cam. The hole in the blank was located and drilled and reamed to this size. Then a mandrel was turned to fit the blank and template, of the form shown by the assembled piece, Fig. 2, leaving a collar to render the template less springy. After throwing out the cross-feed screw of the lathe so that the cross-slide was free, the compound rest was turned at right angles to the slide

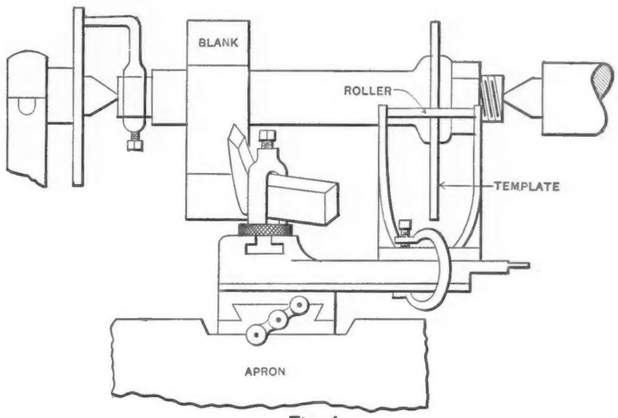


Fig. 1.

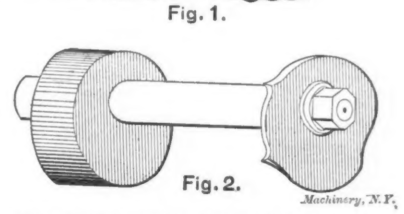


Fig. 2.

MANDREL, TEMPLATE AND BLANK.

and a small roller was clamped at the free end, Fig. 1, to take up some of the friction of the template. This left the tool-post open to take in any of the tools necessary to do the work. At the back of the lathe I rigged up a lever and pulley, Fig. 3, making the

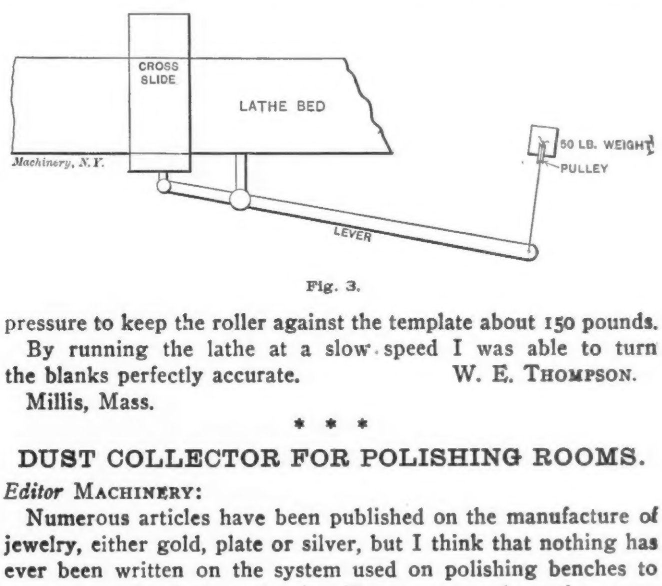


Fig. 3.

pressure to keep the roller against the template about 150 pounds.

By running the lathe at a slow speed I was able to turn the blanks perfectly accurate. W. E. THOMPSON.

Millis, Mass.

* * *

DUST COLLECTOR FOR POLISHING ROOMS.

Editor MACHINERY:

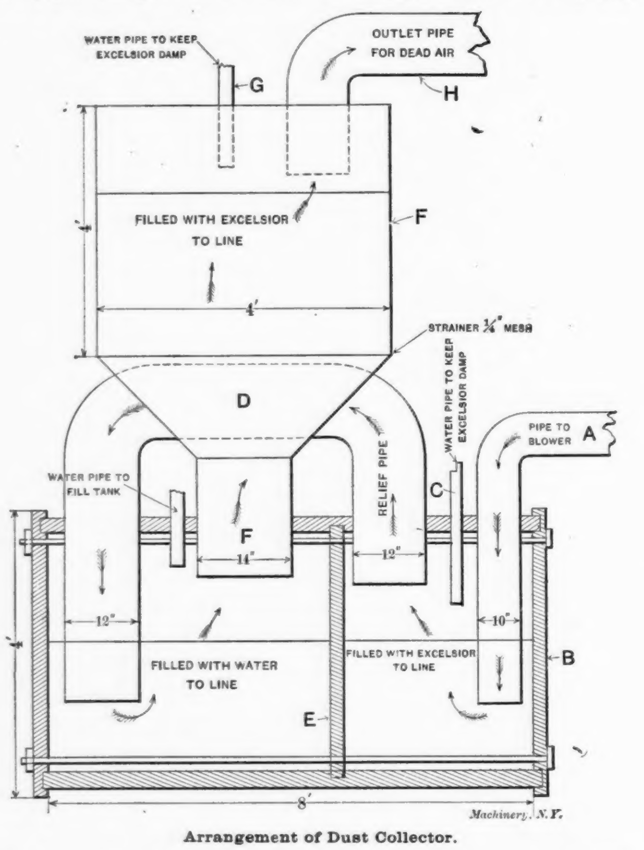
Numerous articles have been published on the manufacture of jewelry, either gold, plate or silver, but I think that nothing has ever been written on the system used on polishing benches to carry away the dust so that it will not escape about the room, and at the same time to save it for refining. The following is a description of one of the systems most in use:

The bench varies in length according to the number of lathes used. A system used for a bench of twelve lathes will be described here. The lathes are of the ordinary type with a screw-spindle on the end of the shaft, which runs from 2,000 to 2,500 revolutions per minute. The wheels are made similar to brushes, except that they are round, and about 4" in diameter. They are used in connection with what is termed rotton-stone (which comes in cakes similar to soap) and serve to do the roughing. To finish or gloss, a cloth wheel is used, which is made by taking ordinary cotton cloth, cutting out round pieces about 6" in diameter and fastening them together till the wheel is about 1/2" thick. On this wheel is used what is termed rouge or crocus, which is the most penetrating preparation I know of. A very small quantity of dust from the crocus wheel magnifies as it collects on the walls and ceilings of the shops and furnishes a richer color than a coat of paint.

The polishing bench is made of matched boards and is, as a

rule, 2' 6" wide and covered with zinc. At the back of the bench runs a pipe 6" in diameter with 2" holes cut opposite each lathe, these being used to connect the hoods that cover the wheels. The 6" pipe is connected with the suction end of a blower. This draws all the dust from the polishing wheels into the pipe, through the blower into pipe A at the end of the blower. The air and dust follow the course of the arrows (see sketch) down the pipe into the tank B, then into the excelsior, which is kept damp by water from pipe C. The dampness causes the dust to adhere to the excelsior. After passing through the excelsior, whatever dust passes together with the air enters into the relief pipe D and through to the other side of the tank into the water box. The tank has two separate compartments, being divided by partition E. The air and dust having reached the water, only a small portion of the dust remains and the air passes into the drum F, through the strainer into the excelsior.

The air is now "dead" and practically all the dust is out of it. The dead air passes through the excelsior and out through pipe H, which generally goes out through a window. The theory of the system is to circulate the air till, being dead, it drops all the dust. It will be seen by the sketch that the air enters the tank through a 10" pipe, and goes from that to a 12" pipe, thence to a 14" pipe.



Arrangement of Dust Collector.

The increase in the size of the pipe serves to lessen the velocity of the air. The excelsior in the drum is kept damp by water from pipe G. When the tank and drum are in need of cleaning, the top of the drum is removed and the excelsior removed and packed in barrels. The tank has trap doors for each compartment and the excelsior is taken out thereby, then the water is drawn from the water box. All the sediment at the bottom is put into a barrel and is sent to the refiners, where the gold, or silver, may be removed and saved.

The amount of metal saved each year by this system is surprising. At the same time its removal keeps the shop clean and free from dust. I know of one firm using this system whose refinings, last year, amounted to $10,000, which saving exceeded the expense of running the office. A. F. NOTROH.

Providence, R. I.

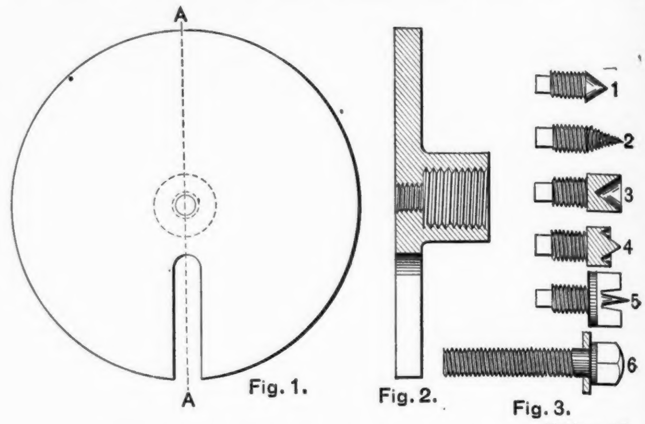
* * *

A UNIVERSAL FACE PLATE.

Editor MACHINERY:

Below will be found a sketch of a novel face plate for lathes. The cut is so plain that it hardly needs any explanation. Fig. 1 is a plan view. Fig. 2 is a sectional view on line A A of Fig. 1. Fig. 3 shows the various forms of centers that can be used, and a variety of others will suggest themselves.

Instead of the usual sized face plate with the full-sized hole clear through for the nose of the live spindle, the hub to this one is made longer so as to throw it out past the end of the spindle. A hole is then tapped exactly in the center of the plate of a convenient size for taking in all kinds of centers. No. 1 is the ordinary 60-degree center for iron. No. 2 is a screw center for turning rosettes or small articles of wood. No. 3 is a hollow center to be used for either wood or iron. No. 4 is another style of hollow center, while No. 5 is the ordinary spur center for turning



Universal Face Plate with Examples of Centers used.

wood. It will be observed that the back end of all of these centers is made square and they can be screwed in or out by removing the face plate and using a socket wrench. The same result could be obtained much easier on all of the centers except No. 2 by putting a square or hexagon shoulder on the outside next to the face plate. This would not work, however, for the screw chuck No. 2, for the reason that the work should be screwed up against the face plate. The bolt and washer shown at No. 6 is to be used for fastening work to the face plate and a number of these can be made of different lengths. The great advantage of the face plate is that it is always ready for all kinds of work by simply changing the centers and from the further fact that the centers are much more easily made and take less steel than the full-sized taper centers ordinarily used.

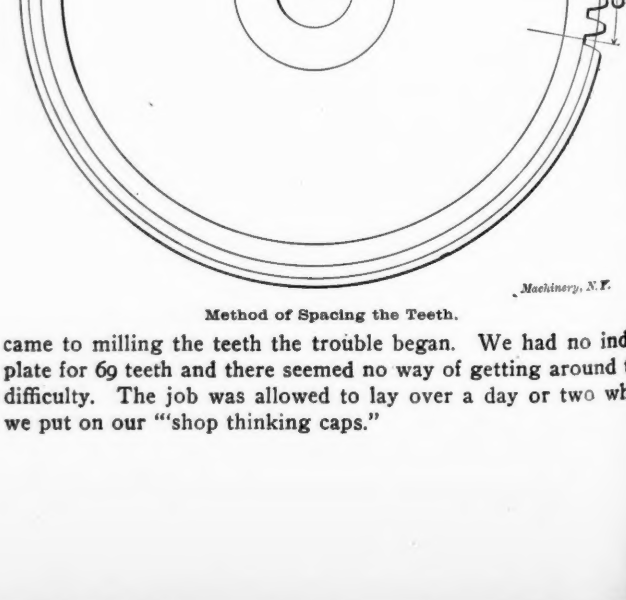
Burlingame, Kan. CHAS. G. TAYLOR.

* * *

ONE WAY OF CUTTING A GEAR WITHOUT THE PROPER INDEX PLATE.

Editor MACHINERY:

We had occasion, some time since, to cut three change gears for one of our lathes requiring 69-tooth gears to cut 11½" thread. There was no trouble getting the blanks, but when we



Method of Spacing the Teeth.

came to milling the teeth the trouble began. We had no index plate for 69 teeth and there seemed no way of getting around the difficulty. The job was allowed to lay over a day or two while we put on our "'shop thinking caps."

Accompanying this is a sketch showing how the work was finally done. The index head was set for 23 teeth and two cuts were made at section A in the sketch about 2-3 of the depth required. We next laid off two places with dividers, for two more cuts between the two already made, and turned the index around until the center of the cutter coincided with the line of space on the blank and then we cut two more spaces. We now had three teeth cut less than full depth, which gave us a chance to caliper for thickness and, if not found exactly alike, to make them so by moving the index of either forward or back. See section B, 1, 2, 3 and 4 for second operation. After this operation was completed the table was raised for full depth of cut and three full-depth teeth were cut, being correctly spaced. Section C shows four 2-3 depth and section D, three cuts full depth. Of course, the four moves were all in one section of the blanks.

To cut the remainder we started at one of the three and cut 23 teeth around and then made a new start and another round which completed the gear, as well as could be done with a plate for the purpose. This saved the cost of buying or making a plate that would probably never have been used again and it took but little longer than if the plate was at hand. E. J. B.

Dubuque, Ia.

* * *

SOME APPLICATIONS OF EPICYCLIC GEARING.

Editor MACHINERY:

The articles on epicyclic gearing recently given in this journal have reminded me of some peculiar applications of this interesting form of mechanism, and especially of three epicyclic trains designed to closely approximate the incommensurable ratio existing between the circumference and diameter of a circle or 3.14159265 + correct to eight decimal places.

To get this ratio to more than two decimal places with simple gearing does not appear practical. The approximation obtained with gears having 7 and 22 teeth or multiples of these numbers, is not sufficiently refined for accurate rack cutting machines, although usually close enough for the gearing of a screw cutting lathe when threading worms to run with diametrally pitched gears. With such a train of gearing the ratio obtained is

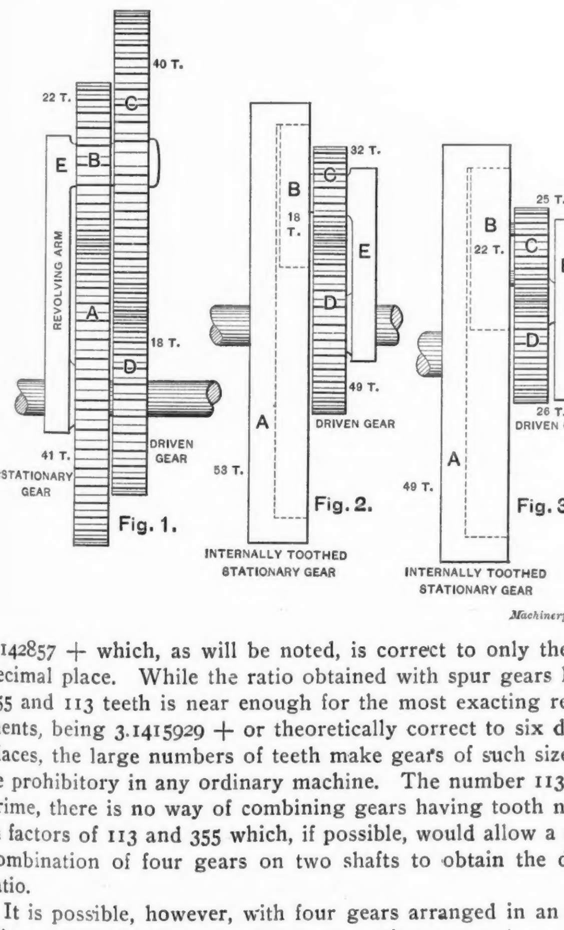


Fig. 1. Fig. 2. Fig. 3.

3.142857 + which, as will be noted, is correct to only the third decimal place. While the ratio obtained with spur gears having 355 and 113 teeth is near enough for the most exacting requirements, being 3.1415929 + or theoretically correct to six decimal places, the large numbers of teeth make gears of such size as to be prohibitory in any ordinary machine. The number 113 being prime, there is no way of combining gears having tooth number in factors of 113 and 355 which, if possible, would allow a simple combination of four gears on two shafts to obtain the desired ratio.

It is possible, however, with four gears arranged in an epicyclic train to closely approximate the ratio 3.14159 + as will be seen from the following: In Fig. 1, four spur gears are shown mounted as an epicyclic train in which A having 41 teeth is the stationary gear. B and C are mounted on the revolving arm E, and have 22 and 40 teeth, respectively. The driven gear D has 18 teeth and rotates 3.141414 times for each revolution of the train as shown by the following demonstration:

	A	B	C	D
All gears locked together	$+1$	$+1$	$+1$	$+1$
A returned to original position	-1	$+\frac{41}{22}$	$+\frac{41}{22}$	$-4.141414+$
Resultant ratio of D				$-3.141414+$

This train, therefore, gives a ratio correct to the third decimal place and closely approximates the fourth. It is, of course, evident that the tooth pitch of A and B is not theoretically the same as that of C and D, the latter being somewhat finer. The difference is not so great, however, but that the same pitch could not be used with involute teeth, having A and B cut so that the pitch line comes about one-fourth of the diametral pitch above the center of the teeth and C and D with the pitch line one-fourth the diametral pitch below the center of the teeth.

The same ratio can be obtained with an internally toothed stationary gear, as shown by Fig. 2. The stationary gear A has 53 teeth, B and C, mounted on the arm E, have 18 and 32 teeth respectively and the driven gear D 49 teeth.

	A	B	C	D
All gears locked together	$+1$	$+1$	$+1$	$+1$
A returned to original position	-1	$-\frac{53}{18}$	$-\frac{53}{18}$	$+2.141414$
Resultant ratio of D				$+3.141414$

In this case the direction of rotation is the same as that of the train carried on the revolving arm E, a condition which might in some instances be very desirable.

With the same arrangement of gearing as given in Fig. 2, but with different tooth numbers, it is possible to obtain a still closer approximation, as will be seen from an inspection of Fig. 3. In this train the stationary internally toothed gear A has 49 teeth, B and C 22 and 25 teeth and the driven gear D 26 teeth. The ratio obtained by this combination is remarkably close to theoretical accuracy and would, without question, satisfy the most exacting requirements of shop practice. The demonstration follows:

	A	B	C	D
All gears locked together	$+1$	$+1$	$+1$	$+1$
A returned to original position	-1	$-\frac{49}{22}$	$-\frac{49}{22}$	$+2.1416083$
Resultant ratio of D				$+3.1416083$
True ratio				$3.1415926+$
Difference				$.0000157+$

This train, therefore, gives an approximation which is practically correct to the fifth decimal place. The pitches of gears C and D may be made one-half of that of A and B by equalizing the slight error of pitch distance as explained for case No. 1. There is another mechanical difficulty with train No. 3, which is, that gear B reaches nearly to the center of shaft F. However, by having the shaft revolve with the arm E, this defect is easily overcome as the shaft can be cut out for clearance and still leave it amply strong.

There may be other combinations of epicyclic trains that will give a still closer approximation to the true value of π than the last one given, but their discovery will require considerable labor, being as far as the writer knows, entirely dependent on a series of inspections and trials to find the numbers of gear teeth that will satisfy the requirements of a practical train and still give the desired ratio.

An interesting form of epicyclic gearing which, so far, has not been mentioned in the articles on the subject, is that of the type known as the sun-and-planet motion made famous by James Watt in his application of it to the steam engine. In this form of epicyclic train, the gear corresponding to gear A in the preceding examples, is not stationary in the sense that it has no motion, since it revolves around a center of motion without rotating. When the planet-wheel moves in this manner on the inside of an annular-toothed gear, we get the combination outlined in Fig. 4. The center C′ of gear B revolves about the center C of the internal gear A but does not rotate, the arrow D pointing all the time in a fixed direction. The result is that with A having 64 teeth and B having 48 teeth, the gear A will turn on its axis one-fourth rotation for each revolution of B around the

center C. To increase the ratio between the revolution of B and the resultant motion of A, it is necessary to increase the diameter of B making the difference in number of teeth between the two gears less. It is evident that there is a limit to the allowable difference since gears cut, as ordinarily, must have at least twelve teeth difference in order not to interfere. This difficulty can be overcome by modifying the tooth shape both in contour and by cutting it off at the top, but the most practical method for ob-

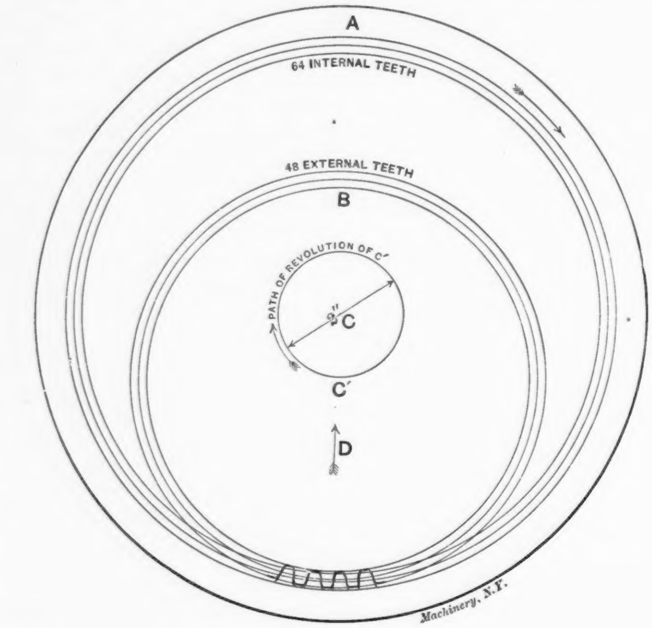


Fig. 4.

taining a high ratio with this form of gearing or a modification of it, is that adopted in the "wabble gear" of the mowing machine. This interesting application of epicyclic gearing has probably been more used than any other, as thousands of mowing machines have been made and sold having this method of transmitting the motion of the driving wheels to the cutter bar. It is said to have been originally invented for a hat machine, but not proving successful in this direction was applied, as stated, to the agricultural implement.

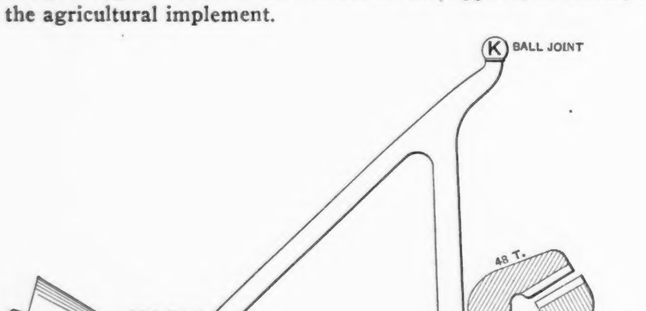


Fig. 5.

This form of epicyclic train is outlined in Fig. 5 in which C and B are two gears, gear C being internally toothed and gear B being externally toothed and resembling a bevel gear. Gear C is so mounted that it cannot rotate, but is free to oscillate on the universal gimbal joint D. The frame J is rigidly connected to C and is pivoted in the revolving part H. By this means gear C is constrained to oscillate or "wabble" in a regular manner, every portion of it describing a circle of a diameter depending on its distance from the center of the universal joint. In this way the teeth of C are meshed with those of B all around the periphery for each rotation of the part H. The part H turns on the fixed shaft I and acts as a sort of flywheel to maintain steadiness of action besides constraining C to "wabble" in a circular path. Since gear C has 48 teeth and gear B has 46 teeth and the conditions are identical to those existing in Fig. 4 with the exception that the fixed gear is on the outside, it is evident that gear B, which is free to turn on its axis, or shaft A, will be displaced two teeth for each oscillation of C on the universal joint. Consequently 23 oscillations of the frame J will be required to turn B around once. Conversely one rotation of B will cause 23 oscillations of C and consequently 23 rotations of H. The frame J is connected to the cutter bar at K, so that one turn of the driving wheels which are mounted on shaft A, will give 23 vibrations of the cutter bar.

By the peculiar form of gears B and C, it is possible to use two gears having a difference in number of teeth of only two which would be practically impossible with gears having the tooth axis parallel with the axis of the shaft. The "friction of tooth approach" is also greatly reduced, thus making the efficiency of this type of epicyclic gearing nearly as high as that of a train of spur gears having the same velocity ratio. With the usual forms of epicyclic gearing in which a high velocity ratio is obtained, the efficiency of transmission is low on account of the abnormal tooth friction.

F. Emerson.

Newark, N. J.

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ABOUT STEP BEARINGS.

Editor Machinery:

Among the valuable sketches in Machinery for August, I would say the one treating on "Step Bearings" is very valuable to all who have such bearings under their charge.

This style of bearing is essentially different from one in a horizontal position, and if not put up right in the first place, it will be a continual nuisance, especially so if there are any bevel gears on the upright shaft, for a drop of ⅛ inch or ¼ inch will throw the gears out or in mesh, according to whether the "driven" gear is above or below the "driver."

Nine years ago I had a step bearing under my charge with a total weight of about 20,000 pounds on the step. From the very first, it gave trouble. No matter how much oil we had in the bearing box, it would start off with a squeaking, grinding noise and inside of thirty minutes would have the oil smoking. Toe after toe and bearing after bearing were put in, but the trouble kept up, until fall, when the plant closed down for the winter. Before starting up in the spring I was given the privilege of trying anything I could think of. I went to the shop and had two pieces of steel turned up true 3½ inches in diameter and ⅞ inch thick. In each of these discs two plugs were put so that they stuck out ¾ inch and were tapered at the points, as shown in

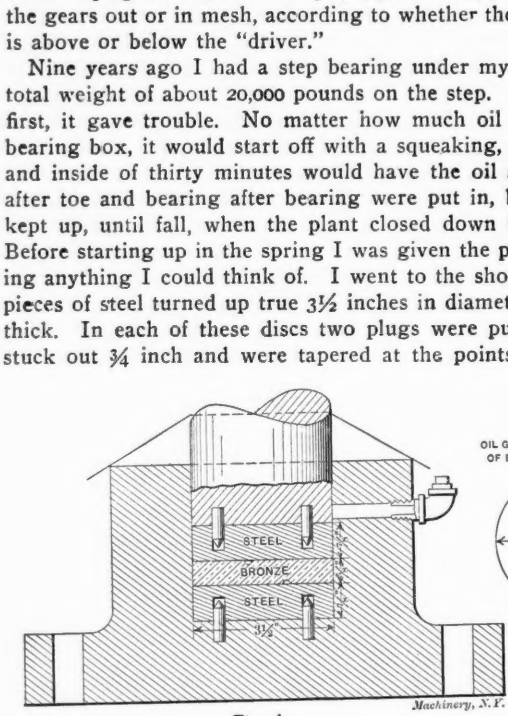


Fig. 1.

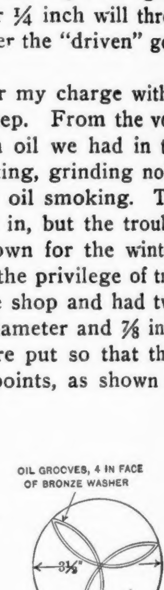


Fig. 2.

Step Bearing.

Fig. 1. I then jacked up the shaft and with a ratchet drill bored two holes each in the bottom of the shaft, and in the cast-iron box at the bottom, then the steel discs were put in the box and one on the end of the shaft. The plugs caused one part to turn with the shaft and held the other stationary to the bottom. Between these discs was put a phosphor bronze plate, Fig. 2, ⅝ inch thick with three small grooves ⅛ inch deep and ¼ inch wide cut in the face on both sides. I let the whole thing down into a mess of oil and graphite and started. With the exception of the first hour it never got warm. The two steel plates after being turned up were tempered hard. A piece of tin fitted around the shaft, right over the bearing, kept out all dust. After two months' running the bearing was examined and found in good shape.

The bearing box was drilled and tapped for a ¾ inch pipe and

a short nipple, ell and plug were put in for oiling. This rig was thrown out last fall for a larger machine, and upon examination it showed some wear on the bronze disc, but none on either of the steel bearings. Too much care cannot be taken when first erecting machinery of this class. Both the bearing and shaft must positively be in line and set solid and plumb, otherwise trouble will be experienced. Any mechanic with a level, plumb and ratchet drill, can fix a step-bearing as was done in this case. without much trouble. The cost will mainly be in the two steel and bronze discs, which cost me $3.50 at the shop.

HOT BOX.

* * *

A REMARKABLE PIECE OF WORK.

THE CONSTRUCTION OF "LONG CECIL," A 4.1-INCH RIFLED BREECH-LOADING GUN, IN KIMBERLEY, DURING THE SIEGE OF 1899-1900.

During the siege of Kimberley the British were in possession of no guns large enough to effectually reply to the 15-pdrs. that were trained against them by the Boers, and it was suggested by George Labram, Chief Engineer of the De Beers Consolidated Mines, Kimberley, that it might be possible to construct a gun in the shops of these mines that would be effectual at long-range firing. Opposition was encountered among the military authorities, but this was eventually overcome, and on Christmas, 1899, Cecil Rhodes, chairman of the company, gave the order to Mr. Labram to make the attempt. Work was immediately started, and the outcome was successful, in spite of the fact that no one there was experienced in either the design or manufacture of ordnance, that work had to be rushd to the utmost limit, and that the shells of the enemy were continually passing over the machine shop buildings, or exploding near them. In 24 days a breech-loading rifle of 4.1-inch bore was ready for trial, and, considering the difficulties under which it was produced, credit must be accorded those engaged in the undertaking of having accomplished one of the most interesting and remarkable feats in machine work on record.

A paper was read by Mr. Edward Coffe before the June meeting of the Institution of Mechanical Engineers, at London, describing the work upon this gun, and we are indebted to this and to the "Engineering News," which republished the paper, for the abstract that follows:

Design and Calculations.

Approximate calculations only were made, for two reasons, one that it was not considered necessary to go into very fine calculations when the two principal factors, the powder pressure and the test strengths of the materials to be used were not known, and could only be estimated, recourse being preferably made to comparisons of the performances of similar guns. The other reason was that time was pressing—the designing and supplying of sketches going on simultaneously with the making of the gun in the work shops.

The article on "Gunnery," etc., in the Encyclopedia Britannica; the military treatise on "Ammunition;" articles on modern guns, in "Engineering," etc., and the military text book on "Gunnery," which an enthusiastic volunteer officer brought forward, proved very serviceable.

From data available, it appeared that 50,000 pounds per square inch would be a suitable maximum pressure to allow for. Upon this basis the strength was next figured out, and the tube alone first taken. Using a formula for the strength of a thick tube, subjected to 50,000 lbs. per sq. in. internal pressure, the greatest stress in the material was found to be 70,000 lbs. per sq. in. This showed, as expected, that the tube could not be used without shrunk rings. By shrinking on two rows of rings, each 2 ins. thick, a reduction of the greatest stress in the tube to about 40,000 lbs. per sq. in. and that in the rings to 20,000 lbs. per sq. in., was calculated, and this it was considered safe to allow.

Shop Work.

The material available for the gun was a billet of hammered mild steel (originally intended for shafting), 10 1-2 inches in diameter, which really suggested to Mr. Labram the possibility of making the gun, and a number of heavy bars of Low Moor iron.

The order to make the gun was given on the evening of Christmas day, 1899, and at the start of work next morning the billet of steel was taken into the machine shop. A lathe of 24 in. swing, with bed 14 ft. long, was used, the extra length of bed required for working the boring bars and rifling gear being obtained by the use of the bed of a similar lathe set in line with it, with the headstock removed. This was already in position, being used when working on lengths of shafting, etc.

Most of the men required on the work had to be temporarily withdrawn from the redoubts where they were stationed, forming part of the Town Guard.

Fig. 1 shows the general construction of the gun. The steel billet was first turned all over outside, a shoulder of 1/8 in. being made to take the thrust of the trunnion ring, the largest diameter being 10.5 ins. It was turned tapering towards the muzzle, a parallel part, about 9 ins. long being left there to be used as a journal when boring. For boring, the breech end was held in a dog chuck, with the muzzle revolving in a hard wood bearing, and first a twist drill 1½ ins. in diameter was put through. This was followed by a twist drill 3 ins. diameter; then the end was counterbored with a tool and a boring bit, Fig. 2, was started, enlarging the whole in one cut to 3 15-16 ins diameter. The bit was plentifully supplied with water through the bar, which was one belonging to a diamond boring drill.

While this turning and rough-boring was being done, which occupied about a week, the rings were being forged, nine being wanted for the first row, 10¼ ins. diameter inside (less shrinkage), and four wanted for the outside row, about 14¼ ins. diameter. These were all made from the 6 × 2½-in. Low Moor iron, a length of bar being cut, bent to a circle, and the ends welded together. As these were finished, they were passed on to the machine shop, where they were turned, faced and bored to gage. The trunnion ring was a greater undertaking than the plain rings, and the difficulty of making a satisfactory weld in so heavy a piece of work with the appliances at his command, was overcome by the leading blacksmith, by working it out of a length of 6 × 6-in. Low Moor iron, starting a small hole through the center, and enlarging by successive heats, until he had it to the required size for machining.

By the time the rings of the first row with the trunnion ring were made, the tube was ready to receive them. For shrinking, the tube was held vertically under a convenient derrick in the yard, first with breech end upwards. The ends of the bore were plugged, and a circulation of cold water arranged inside to keep the tube cool. The rings were heated on a plate over a wood fire, the bore being gaged until sufficient expansion was evident, then lifted by the derrick over the end of the tube, and dropped into place, the trunnion ring being the first to go on, resting against the shoulder. As a precaution against possible travel endways while cooling, each ring was clamped by longitudinal bolts, and the adjoining one on which it rested kept cooled down by a stream of water from a hose pipe. The tube was reversed to put on those rings in front of the trunnions, and the whole of the first row being in place, it was returned to the lathe, and the outside of the rings turned up to form a seating for the second row, over the powder chamber. The process of shrinking these was the same as for the first row, and when they were on, the barrel was again returned to the lathe for finishing. The final boring was then begun, the tool used being a studded bit, with double-ended cutter, Fig. 3.

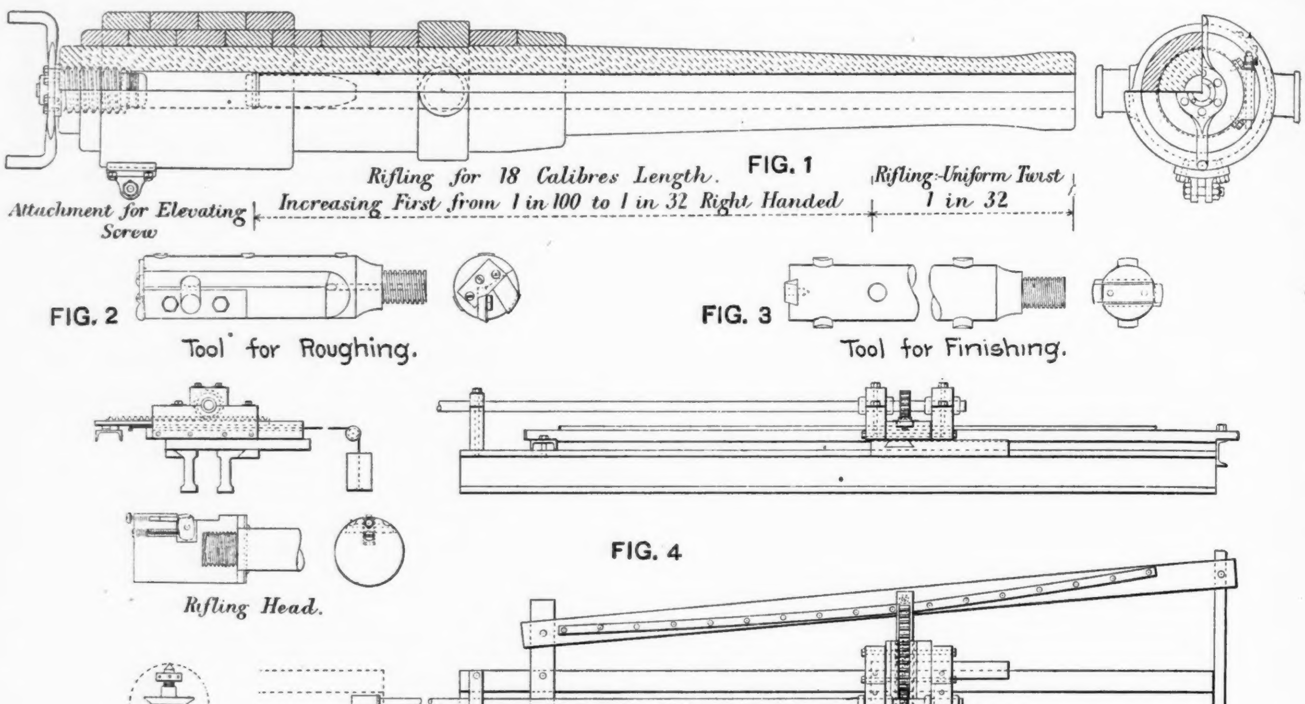
Meantime, the question of rifling had been gone into, and the increasing twist appearing more desirable and easier on the gun than the uniform twist, it was decided to make it so. To effect this, the rifling attachment, as shown in Fig. 4, was devised. The drawing shows a channel iron bolted to two cross channels, which are bolted to the ends of the lathe bed. On this channel-iron the developed curve of the spiral—a semi-cubical parabola—was set out by its ordinates. A planed bar, to act as a former, was bent to the curve, and screwed down with counter-sunk screws. The hardwood blocks forming the guides to the rack and bearings for the rifling bar, were bolted solidly together and to the saddle of the lathe. The end of the rack (which is one as used on the mine washing machines) was furnished with one little roller, travelling on the "former" bar, contact being kept by a cord attached to the under side of the rack, carried over a pulley at some distance and having a weight at the end. A small guide pulley should be shown on the saddle, to allow for vibration of cord with travel of saddle. The traversing of the saddle was done by the lead

screw of the lathe, a small belt pulley being put on in the place of the usual "change" wheel, with a belt from the overhead drive.

A detail of the rifling head is shown in Fig. 4. It was formed of a solid block of steel, turned to fit the bore of gun, into which the end of the rifling bar was tightly screwed. The tool was able to revolve slightly on its pin as a center, being kept up to position by the set screw and packing block, which also regulated the depth of the cut taken, while clearance on the return stroke was possible by the giving of the spring. A felt pad, held by a

machine, Fig. 4a, was made, being worked by a gut band from a convenient source of power.

The breech block and obturator are shown in detail in Fig. 5. The De Bangé system of obturation was adopted, that appearing to be the most efficient and easily made. The obturator pad was made of rings of sheet asbestos soaked in melted tallow, and proved quite successful. The breech-block, as made first, and used with radial firing is shown in Fig. 5A. The block was of hammered mild steel, the same material as the tube of the gun,



Sketches Illustrating Details of Work on the 4.1-inch Gun.

washer, was attached to the head, in front of the tool, while the head drew another wad of felt behind it, to clean the bore of cuttings, as made, and a supply of soapy water, under pressure, was forced in behind the head, two semicircular grooves being provided to allow the supply to get to the cutting edge.

The breech-block screw having meanwhile been made, the inside was cut and the block fitted in. In cutting this thread in the barrel, the question of the ending of the cut inside had to be met, and the simplest way seemed to be to let the tool finish in a clearance hole, and to drill this hole inside. The little drilling

threaded with a V-thread of ¾-in. pitch, with flattened top and bottom. The handle-bars and plates are one forging, fastened to the screw with six tap bolts. The obturator bolt with mushroom head was made of mild steel, 1½-in. diameter, shouldered near the middle to 1¼-in. diameter, and held by lock nuts in a recess at the back. As thus made, about 100 rounds were fired with this obturator. Figs. 5, B and C, show it as subsequently made, the reasons for which alterations will be described later.

It was arranged originally to have an interrupted screw, cut away in three sections, so that one-sixth of a turn of the handle-

bar would release the breech-block; but consideration of the time to be saved by not cutting it, which it was thought would be at least two days, and the further consideration of strength, induced the author to urge keeping the screw intact, the actual extra time taken in unscrewing the whole way being only a few seconds.

Carriage.

The carriage having been made in the meantime was ready for the gun. It was formed of four steel plates ¼-in. thick, cut to shape, riveted together in pairs, 2½-ins. apart, with distance sleeves on the rivets, and with gun-metal casings also acting as distance pieces and riveted in, for trunnion and axle bearings. The two pairs of plates were bolted together with shouldered bolts, 17¼-ins. apart, and with a rubbing plate at the trail end, which was also provided with an eye-bolt for hanging to limber. The elevating screw was of steel, 2¼-ins. diameter, with square thread, ¼-in. pitch, working in a nut pivoted between the side frames, and provided with a hand-wheel. The axle was 4½-ins. diameter, keyed into the side frames.

The wheels were the only part not actually made, and they were a pair belonging to a portable engine, and suited the purpose admirably. They were bored out, had gun metal bushes driven in, bored to fit the axles, and brass dust caps screwed on outside.

Testing the Gun's Range.

With 24 days of continuous work the gun was ready, and on Jan. 19, 1900, it was taken out for testing and ranging, a firing platform and redoubt having been built from which the Boer headquarters (the Intermediate Pumping Station of the Kimberley Waterworks Co.) and several of their gun positions could be commanded. The ranging was done with the assistance of the company's surveyors, one having a theodolite at the point of firing, while another, also with a theodolite, was stationed at a point about a mile distant, nearly at right angles to the line of fire. On firing each took observations on the spot the shell struck, and the angle of firing, as shown by clinometer, time of flight, charge of powder, etc., also being observed and tabulated, the muzzle velocity was calculated, and range tables made for subsequent use, by Mr. C. D. Lucas.

The Boers appeared much disturbed when the first shells burst in their headquarters, and could be seen hurrying out in all directions, not expecting that they could be reached there, and there was no reply from any gun of theirs during the ranging trial. Mr. Rhodes was present the whole time and personally fired most of the shots, being pleased with the performance of the gun, and the artillerists working it also were well satisfied with its shooting qualities. The trials having been completed, the gun was returned to the workshops for one or two minor alterations. These being completed, it was handed over to the firing party and was in action on Jan. 23.

While in action, 255 shells were fired in all by it, most of them being at ranges of 5,000 and 6,000 yards.

Ammunition.

The "Ring" shell used is shown in Fig. 6. In making the shell the rings were first cast separately, then were mounted on a clay core, alternating tooth and space, as will be noticed, the shell bursting better when thus arranged. This clay core, with rings, was then used as an ordinary core in the mold, and the metal poured.

The shells, after casting, were turned to gage, the point screwed for the fuse, and grooved for the copper gas check, that being made from a ring, turned and cut off to the width required, then cut through with a saw, sprung into place and expanded into the dovetailed groove, afterwards being turned and the relieving grooves cut. The insides of all shells were lacquered.

The percussion fuse was devised by Mr. Labram, his idea being to have the simplest possible one to make. The action of it is that when the shell strikes and its forward motion is checked suddenly, the plunger, which is filled with mealed powder, continues its motion forward, its impetus being sufficient to overcome the resistance of the safety spring and wires. The nipple strikes and explodes the cap, which is an ordinary percussion cap, as used in sporting shot guns, the mealed powder is ignited and fires the charge in the shell.

Repairs and Alterations.

From the time of its being handed over to the firing party on Jan. 23, the gun was fired steadily, the only trouble being a tendency for the end of the breech-block to "upset" and get too tight in the screw. This was easily remedied by first easing the thread and subsequently removing one and then two threads at the end. On Saturday night firing ceased, as usual, Sunday being observed as a day of rest—from gun-firing—by the Boers. But at daybreak on Monday morning the first shot fired by "Long Cecil" was productive of an extra loud and peculiar report. A telephone message came from the redoubt immediately afterward, and an examination showed that the second ring in the outer row had burst through the line of the vent hole. The gun was at once sent down to the workshops for repair. To take off the first ring the foundry cupola was lighted, the gun hung from the crane with the breech in the sand, and a ring of metal run round the first ring, which in two or three minutes expanded and dropped off, releasing also the broken one, to replace which a forging was already in hand.

The outer ring being weakened by having the vent hole through it, with the possibility of the weld happening to be at the same spot, the radial venting was condemned, and the breech prepared for an axial vent. The vent hole in the gun tube was tightly plugged, and the new rings when ready, shrunk on. No alteration was made in the breech block beyond boring the vent hole through the obturator bolt, and providing a safety device to prevent the friction tube blowing out behind and possibly injuring some person. These changes, shown in Figs. 5 A, B and C, being completed, the gun was taken out to the redoubt again and put in action, but at the first shot under the new conditions, the obturator bolt (the same one as had been used all the time, and with which about 100 rounds had been fired) broke, as shown in B, Fig. 5. A spare breech block had already been prepared with the obturator bolt increased in size to 2 ins. diameter, without shouldering, and the end brought right through the back plate, but at the first shot this one also broke off short under the mushroom head. It was beginning to be an anxious time to know how to make something which would stand the shock, when one of the fitters said that he had "known a time at Woolwich when six or seven similar bolts had broken with successive shots"—which statement somewhat relieved the anxiety—and he further suggested annealing in oil, as an expedient which might help. This was immediately done, several bolts being made for emergencies, but none broke after that. The present breech-block is shown at C, which also shows the peculiar drawing-down action taking place in these bolts. Three of them were used with two breech blocks from that time till Feb. 15, when Kimberley was relieved, about 50 rounds being fired by each bolt. The only way to account for the action seems to the writer to be that the shock of the explosion drives the whole bolt back, compressing the asbestos pad. Then on the relief from the pressure, the pad expands again, tending to bring the bolt back to its original position, which is opposed by the inertia of the body of the bolt, causing a tensile stress in the bolt which is sufficient to cause permanent set at the point where the greatest stress comes, close to the head.

* * *

MIGHT GO OFF ON A TANGENT.

Through the alertness of a Wisconsin subscriber, we are able to announce an interesting innovation on the part of the Chicago and Northwestern Railway. The following clipping from a Milwaukee daily which he sends us, gives particulars:

"The Chicago and Northwestern Railway has recently placed in service a new engine, which it is expected will maintain a speed of eighty or ninety miles an hour, drawing an eight-car train. The driving wheels are eighty inches in diameter, and are propelled by 200 pounds of steam on each square inch of the cylinder rod. The engine weighs 160,000 pounds, the four driving wheels weighing 90,000 pounds. There is a trailing wheel which supports an outside bearing, steadying the engine when rounding a curve at a high rate of speed."

* * *

A power hack saw is manufactured in England which is automatic in its action. A bar of metal being placed in the machine and the gage adjusted to the proper length, the machine saws off the pieces, all to the required length and rings a bell when the bar is cut up. The same bell is rung if the saw blade breaks, and also at the end of a cut, when single pieces are being sawed off.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

"Inquirer" desires information about the principles underlying the design of rotary pumps of such a type, for example, as the "Holly" pump. He asks whether the teeth should mesh loosely or snugly, and whether there should be clearance at the bottom of the teeth.

1.—E. A. C. B.: Please explain how to figure gears for cutting double threads with compound gears.

A.—Figure exactly as for calculating change gears for cutting single threads of the same lead. You will find full and clear directions for this in the September, 1899, number of this paper, page 15. Our supply of this paper is exhausted, but if you have not a copy you can easily refer to some other file. Colvin & Cheney's Machine Shop Arithmetic, price 50 cents, also contains directions for making this and numerous other machine shop calculations. After you have geared up the lathe and roughed out one of the threads, move the tool ahead a distance equal to half the lead, and rough out the other threads. Finally, finish the two threads.

2.—J. S. H.: Please let me know through the columns of MACHINERY the standard size of corporation hose connections.

A.—There is no standard for fire hose connections, although that of New York City has been adopted in a number of other cities and towns. The sizes given by Jenkins Bros. for the New York type of 2½" hose connection is as follows: Number of threads per inch, 8; outside diameter of thread, 3"; diameter at base of thread, 2 7-32"; length of thread to collar, ⅞". The nominal diameter of the hole is 2½".

3.—W. P. F.: Why is it that on engines used on torpedo boats, and other vessels where very high pressure steam is employed, the engine cylinders are not made of steel castings, instead of iron castings?

A.—There is generally difficulty in producing steel castings that are smooth and sound. They are very liable to contain air holes, or holes filled with grit and sand. There has been a great improvement in the quality of steel castings within the past few years, however, and we presume that if the castings made satisfactory wearing surfaces, these obstacles would be overcome. You will note that where steel castings are employed, if there are any wearing surfaces connected with them, these are covered by some other metal. It is necessary, almost above all else, to have a high-speed engine wear well and run without cutting.

4.—P. K.: Why does a wheel running on a plane surface move faster at the top than at the bottom? This is a question that was asked me recently, and concerning which I have heard arguments on both sides. Please explain the matter for me, as the subject is somewhat bewildering.

A.—The easiest way to determine the action of a wheel rotating on a plane surface is to take an actual case, so that it may be seen by experiment what takes place. Cut out a piece of cardboard in the form of a circle, and make a notch in one edge, like

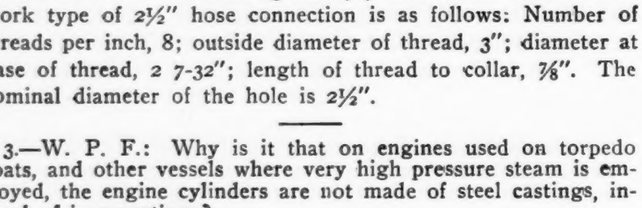


Fig. 1.

N, in the accompanying figure. Now have someone hold a ruler flat on the table for you, one edge of which is represented by the line X Y in the figure, and then run the edge of the cardboard disc along the edge of the ruler, placing a pencil in the notch N, so that a curve will be traced, indicating the successive points occupied by the pencil point for the successive points occupied by the center of the disc. Referring to the diagram, suppose the notch N to be placed at the point 1 on the ruler, the center of the disc being at point A. Rotate the disc until its center reaches point B, and the edge of the disc is tangent to the ruler at point 2. The notch will have then moved to point 2′, and will have made very little progress horizontally. In the next position, with the center at C, the notch will have moved only to point 3′; but with the third position at D, the notch has gained and moved faster than the center, its new position being indicated by 4′. It will thus be seen that as a point in the rim of a wheel nears the top of a wheel, its speed increases and its horizontal or forward movement is greater than the movement of the center of the wheel; while as the point nears the bottom of the wheel, its speed decreases and its movement becomes less than the movement of the center. The relative amount of motion at any point can be found by plotting the points along the curve traced by the pencil, and which is shown dotted in the sketch. The curve is called a cycloid. In the figure different positions of the disc are shown for one complete revolution, during which time the center passes from point A to point I, and the cycloid is traced from point 1 to point 9. Of course it is understood that the rotary motion of the top and bottom of the wheel is always, with respect to the axis, the same.

The following questions upon the gas engine were answered by E. W. Roberts, Cincinnati, O.

5.—W. H.: Will you kindly describe some simple method to figure the B. H. P. of oil engines. It often happens that an engine has been delivered far away into the country, and the machine does not work to satisfaction, the power seeming to be insufficient, and something must be done at once by the engine builder to satisfy himself and the purchaser that the engine is of the power required. If you cannot afford to rip up a complicated brake expressly made for such a purpose, and only desire an approximate figure, what should you do? More or less accurate methods are used in the neighborhood for such cases, but you may know one that is very simple and good.

A.—In the accompanying sketch is shown a plan by which a brake test may be made with no other instruments than a spring balance and a speed indicator. Should the engine run slowly enough that its revolutions may be counted by the eye, the speed counter may be dispensed with. At F in Fig. 2 is shown the fly-

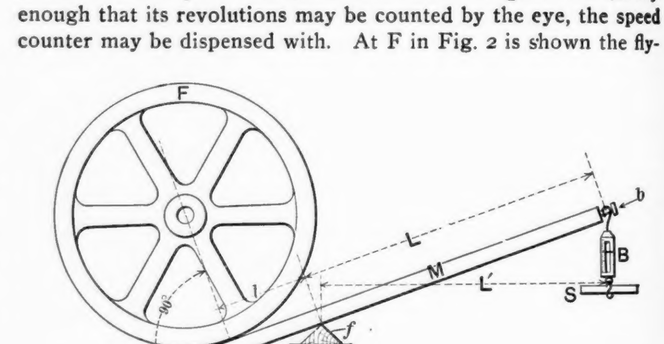


Fig. 2.

wheel of the engine and a stout plank at M, into the end of which has been driven a heavy spike or a lag screw b. On this screw hook a spring balance B, and through the ring of the balance put a stick for convenience when pulling on the balance. The lever M should press against the under side of the flywheel and be supported by a three-cornered block of hard wood f, which acts a fulcrum for M. Have a man pull down on the lever by means of the stick S until the pressure on the flywheel is all that the engine will pull against. Then to find the maximum power of the engine first determine the pressure exerted by the lever M against the flywheel. Neglecting the effect of the lever, this pressure would be:

$$P = LB \div l$$

Wherein L and l are the lengths of the long and the short ends of the lever, respectively.

B is the pressure shown by the balance, and

P is the pressure upon the rim of the flywheel.

If there is much angularity of the lever length L should be taken equal to L′.

The effect of the weight of the long end of the lever may be avoided by balancing the lever with a weight at x when the lever is in use, or it may be found by balancing when the lever is not in use and adding this amount to the value P. The effect may also be determined by mathematics, which it is unnecessary

to explain here. When P has been found the B. H. R. is determined by the following formula:

B. H. P. = .0001904 P R N.

Wherein P is as above and in pounds,

R is the radius of the flywheel in feet,

N is the number of revolutions per minute.

The distance l should be measured from the radius of the flywheel, which is at a right angle to the center of the lever M. On an occasion where it is difficult to obtain a spring balance, a weight may be substituted, but it will not be found so satisfactory.

6.—W. F. C.: I have built a small gasolene motor, and have everything completed but the induction coil, for the jump spark igniter. Will you kindly inform me what size wire, and how much to use, what size iron core to be used, etc. I have made one, but I cannot make it work satisfactorily.

A.—In the first place, cast iron should never be used for the core of any kind of an electric coil, because of Foucault currents which are generated in the core. The coil, if built as follows, and carefully made, will give good results: Build the core of soft annealed iron wire, cut to lengths of 5½ inches. The kind that is known as stove wire will answer very well. Bind a sufficient number of these wires together with tape or other insulating material, to form a core ¾-inch diameter. On this core wind two or three layers of No. 16 (B. & S. G.) magnet wire, making the winding 5 inches long, and allowing the core to stick through ¼-inch at each end. Cover this primary winding with two or three layers of parrafine paper, and wind on top of the paper one pound of No. 32 magnet wire. Connect any convenient form of vibrator in series with the primary circuit, and operate the coil with four or five cells of caustic soda battery. This coil will give a spark of a maximum length of about ½-inch. The points of the igniter plug should be placed a distance apart equal to the thickness of a ten cent piece that is slightly worn. In order to avoid undue corrosion of the contact points of the circuit-breaker, it is necessary to place an electric condenser in parallel with the break. The capacity of this condenser will have to be found by experiment. It will probably be the most satisfactory and economical way to purchase a coil of good make, rather than attempt to make it, as it is no easy matter for an amateur to construct an induction coil suitable for jump-spark ignition.

7.—S. A. H.: I herewith enclose you sketch of an igniter block for a 3-H. P. gas engine. The stem A, to which the battery wire attaches, is stationary. The stem B is forced in contact with stem A, which closes the current, and a spring draws stem B back, which breaks the current and causes the spark at point of contact. Stem B passes through packing gland C; the heat becomes so intense in this igniter block as to melt the end of igniter stems A and B. I repaired this engine by replacing stems A and B with 5-16 iron stems—the old ones were ¼-inch stems Would you not think the longer stems an improvement, and is iron better than steel? In regard to the excessive heat generated in this block, was it not caused by a leakage through gland C?

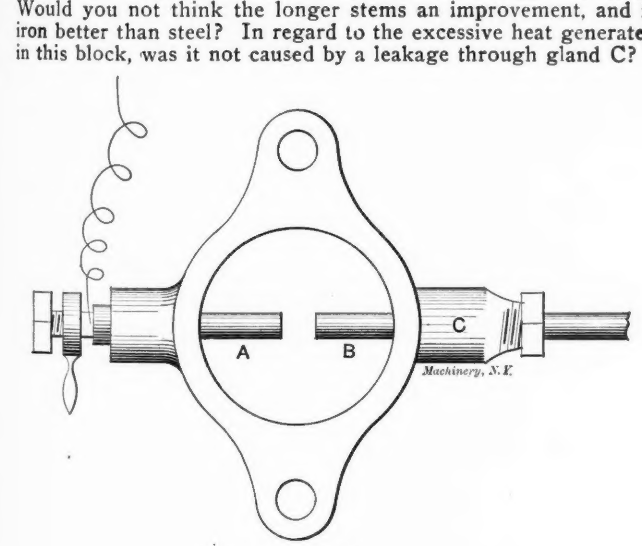


Fig. 3.

A.—This is about as poor a way to make an igniter as could well be devised, for the reason that it leaves the long points A and B fully exposed to the heat of combusiton without any means of cooling them. If the inquirer will refer to the article on Gas Engine Design No. 8, as published in the July issue of MACHINERY, he will find directions for making an electric igniter with hammer break. The only advantage to be obtained by increasing the stems in this particular case would be that they would not heat up so quickly. This is the only improvement that the increased size would produce. Iron is a little better than steel as it does not melt so quickly. A leak past the points will perhaps increase the temperature, but it must be remembered that any piece of metal exposed to a flame at regular intervals, and with no means of being cooled between times, will shortly get as hot as a piece of iron plunged into the fire of a forge. Besides burning off the points and heating them to a high temperature, this would cause ignition from the hot surface of the points, and it will be found that after this engine has been running steadily for say about ten minutes, the igniter current could be cut off entirely and the engine will continue to run without missing explosions. The writer knows another engine in which the igniter was built on this principle, and which could only be run for ten minutes before premature explosions would occur and the engine stop.

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NEW TOOLS OF THE MONTH.

Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.

PNEUMATIC HAND RAMMER.

The pneumatic hand rammer illustrated herewith is designed to meet a large variety of work in the foundry, not only on the floor, but on heavier loam work, where it may be used to good advantage alone or as an auxiliary to the heavier type of pneumatic rammer which is suspended from a crane. This hand rammer is in general design similar to the suspension rammer, but is


Pneumatic Rammer.

made light enough so that its use cannot become irksome to the operator. At the same time it is sufficiently heavy so that its inertia absorbs any variation that may arise from the rapid reciprocation of its piston and the rammer head. The valve mechanism is entirely enclosed, and is as simple as is consistent with proper distribution of air in the cylinder and smooth working. The rammer rod is hexagon in shape, as shown in the engraving, so

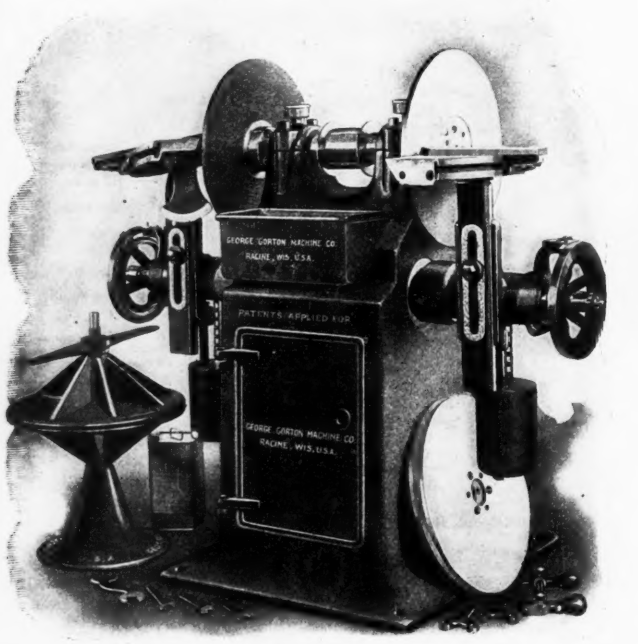
that it cannot turn except at the will of the user. It is also arranged so that the piston will remain at the top of its stroke when the machine is stopped. The weight of the rammer is 45 pounds, and it strikes 250 to 300 plows per minute, using air pressure at from 50 to 100 pounds per square inch. Only 15 cubic feet of free air per minute are consumed in continuous operation.

The machine is provided with a handle on each side; to the handle on the right side is attached the air supply hose, and the admission of air to the cylinder of the rammer is controlled by means of a throttle lever under the thumb of the user; exhaust air passes out through the handle on the opposite side; the speed and force of the blows may be varied at the will of the user. A number of different shaped rammer heads are provided with each machine; they are attached to the rammer rod by means of a taper fit, and may be changed in less than one-half minute without letting go of the handles.

The manufacturers, the Philadelphia Pneumatic Tool Co., of Philadelphia, New York and Boston, are furnishing these machines for a great variety of uses. Besides regular foundry work, it has been found to be a labor-saver in ramming up converter bottoms in Bessemer steel plants, and for various other purposes, in ramming the molds of special shapes of fire brick, for use in glass and other furnaces.

GORTON GRINDER.

The flat disc grinder is to be recommended for finishing and polishing work where it is desired to maintain flat and true surfaces, and yet the work is not of such a character as to warrant its being finished on the regular surface grinder. The disc grinder combines to a large extent the rapidity and convenience of the polishing machine with the accuracy of the surface grinder.



Improved Disc Grinder.

A recent type of this machine is a new design adopted by the George Gorton Machine Company, Racine, Wis., which is illustrated herewith. The pedestal and headstock is a heavy one-piece casting, well ribbed internally, and containing unusually heavy support for the two tables. Both tables have a movement of two inches toward the wheels by hand wheels, and may be swung back and forth across the face of the discs, or clamped rigidly in position. The right hand table is accurately square with the face of its disc, and the left hand table has an angular adjustment. Both have vertical adjustments.

Thorough provision is made for oiling, and the counter-shaft is self-oiling. The parts are dust proof, the adjusting wheels have micrometer readings, and the tables have a counter weight, which keeps the tables in balance, whether vertical or at an angle. Protractors are fitted to the tables, and a disc-cementing press, and other needed accessories are provided.

NEW RADIAL DRILL.

The machine herewith illustrated is a 76" plain radial drill recently brought out by the Hamilton Machine Tool Co., of Hamilton, Ohio, U. S. A., and readily appeals to the user of drilling machinery by its general simplicity and its many conveniences in operating.

The radial arm is clamped to a sleeve, which is carried on anti-friction bearings, allowing it to easily revolve around the column. A particular feature of this machine is that the stump of the column extends to the top of the sleeve, and thus forms a substantial support for the arm, a feature that often does not have sufficient attention.

The arm is well braced, and is raised and lowered by power; the elevating screw is provided with ball bearings, and is operated

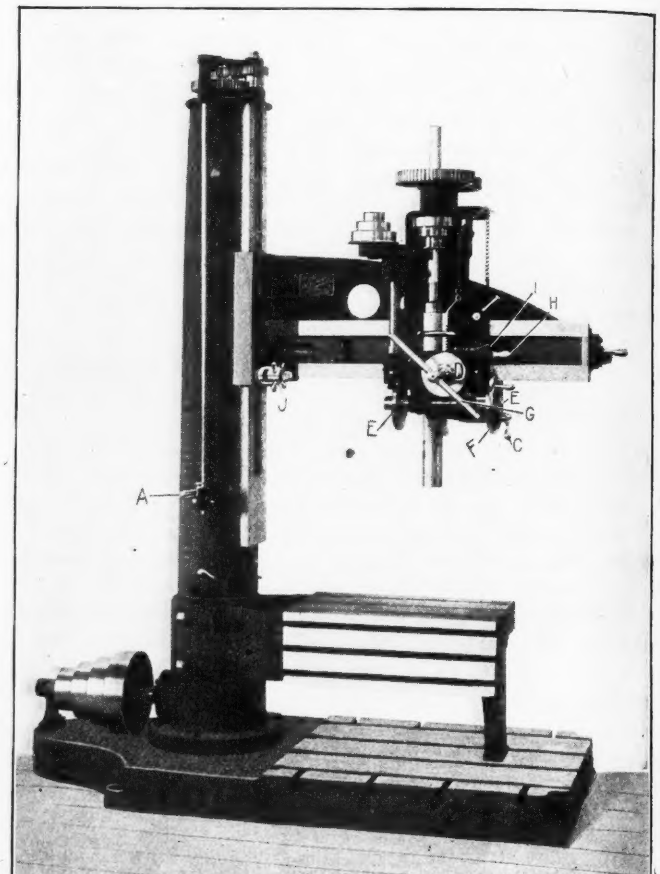


Fig. 1. 76-inch Radial Drill.

by the lever A, Fig. 1. The driving shaft passes up through the center of the column, and transmits its power through the shaft B to the back gears, which are placed behind the arm and close to the face of the column sleeve. This arrangement places the weight of the back gears in a position where it is easily carried, and does away with the objection often raised of making the saddle top-heavy.

The lateral movement of the saddle is accomplished by a rack and pinion, which provides a rapid adjustment always within reach of the operator, the hand-wheel C being used for this purpose. The vertical movement of the spindle is obtained either by power, by means of the small feed shaft at the left of the saddle, acting through the worm and worm wheel D, and controlled by the friction E, or by hand, by means of the hand-wheel F, or quick-return lever G. The worm box is arranged to drop sufficiently to permit the worm wheel to clear; this permits the lever G, operating through a steel pinion and rack, on the quill, to rapidly deliver and return the drill to position. By simply pressing on the handle H, the worm box is brought into position, causing the worm and worm-wheel to mesh, and the handle is automatically locked into position by the small spring latch I.

The spindle is started or stopped, or the back gears thrown in, by moving the pilot-wheel J a quarter turn either way, and without resorting to the counter-shaft. This pilot-wheel is graduated